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WORLD OIL

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IN THIS ISSUE . . .

New exploration technique points to four productive areas around Hainsville Dome. Proper use of temperature and earth alteration can lead to structure definition . . . Exploration Section

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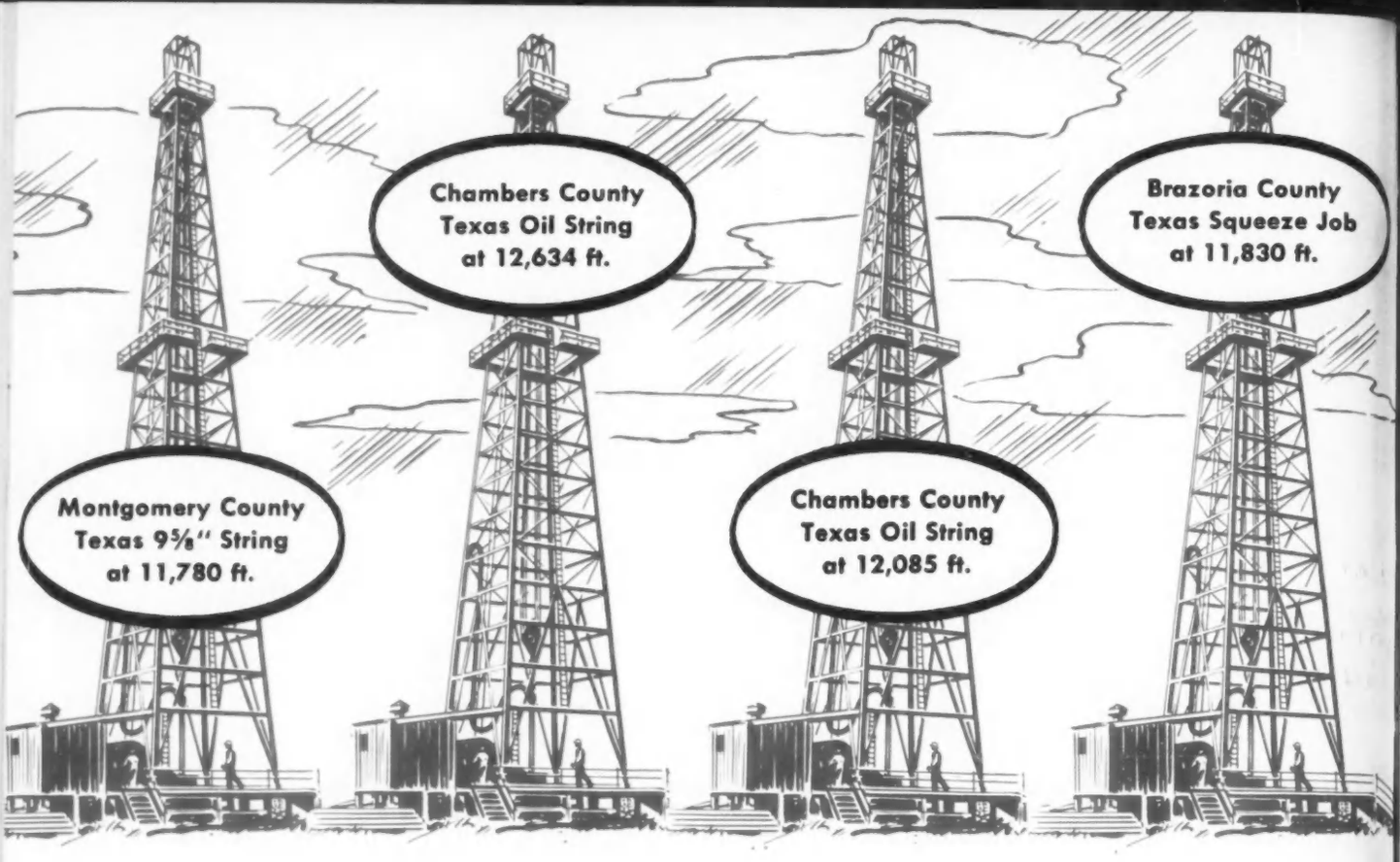

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WORLD OIL

Established 1916 as The OIL WEEKLY

a quick look at WORLD OIL this month

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

Special Report

. . . on exploration techniques

☐ **Significant reserves have been uncovered** in the Ordovician and Pennsylvanian systems of the Lower Paleozoic in western Oklahoma. Offered as a field development report, this special series includes pertinent drilling, geological and production data on the area in question. Turn to **Page 107** for the story of **Significant Lower Paleozoic Discoveries in the Anadarko Basin** **Joseph A. Kornfeld**

☐ **Contrary to the common practice** of reviewing the history of productive but exhausted pools, here's an author who breaks with tradition of post-mortem reporting and submits . . . as a test of a new exploratory technique . . . four promising areas around the Hainsville dome. See **Page 113** for the article **New Method Indicates Productive Area**.....**Mark Milstein**

Turn the Page ▸

THIS MONTH . . .

☐ **Geophysics, stratigraphy and physical oceanography** . . . modern day tools used in exploratory efforts . . . have joined forces to determine the existence and extent of underwater petroleum reserves. Widespread marine exploration still remains untouched territory to the oil finder. And with a growing need for new petroleum reserves, the scientist is applying all known rules of the game to untangle the secret of untold mineral wealth clamped tight in Davy Jones' locker. For a look at the areas offering the greatest marine potential and for an idea of the exploration methods used offshore, turn to **Page 116. Areas of Interest in Marine Oil Prospecting**.....**T. R. Goedicke**

☐ **API research and other investigations** during the late 1920's and early 1930's indicated that surface and near surface temperatures reflect geologic structure. For a re-introduction to the basic factors involved, together with their significance to the alteration study method of mapping, turn to **Page 123** for Part 1 of **Surface Alteration Utilized in Structural Mapping—A Function of Earth Temperature**. . .**Bernard H. Lasky**

☐ **A detailed study of the phenomena** of the internal waves, tsunamis, and other factors may lead to the better understanding of the phenomena of deposition and erosion in the oceanic waters. An observation of V. G. Gabriel, Houston consultant, who has made an extensive study of offshore beds, a subject of great current interest due to intensified offshore exploratory effort. See **Generalized Unda Environment in Time and Space**.....**Page 130**

CURRENT OUTLOOK

☐ **Flossie gave Louisiana offshore operations** their first real hurricane test since intensive drilling activity began in 1947. Out of the storm came many new ideas for better hurricane precautions and ways to cut down future damage. In this exclusive WORLD OIL survey you will find a comprehensive report on amount and type of damage resulting from Flossie—evacuations and the "calculated risk"—storm mooring methods—problems created by flow gathering line risers—marine lawyers' opinions on the salvaging of unattended vessels—plus a company-by-company report on hurricane damage and experience gained. Turn to **Page 72. Offshore Operators Look At Flossie's Damage.**

Don E. Lambert

☐ **Turn to Page 100 for** . . . a month-to-month record of the nation's crude output . . . what the industry's refineries are doing and how their product inventories are stacking up against last year's . . . how oil imports' role continues to grow. Then by flipping the page you get a quick look at the record of the nation's drillers . . . wells and footage drilled and how many rigs are currently on the job. For those who want to delve deeper than the scan readers, there is a wealth of industry information also contained on these pages 100, 101, 102 and 104.

☐ **Oil industry management** needs to develop more skill in balancing oil inventories with market requirements. Failure to keep refinery runs and stocks in line with market needs has caused a current surplus of gasoline. This oversupply was accumulated in past months in spite of general knowledge that it was being built up. This year's mistake in over-building inventories is a repetition of the same error made repeatedly in the past. Management deserves credit for developing reserve operating capacity. But it needs to develop the skill to avoid converting the reserve capacity into temporary surpluses that hurt the industry. See **Page 75. Better Management of Oil Inventories Needed.**

L. F. McCollum

☐ **Further growth of petroleum consumption in the U. S.** and in other free countries is foreseen for 1957. The gain in the U. S. is expected to be about 4.3 percent. This will follow an increase of 5.4 percent in 1956. Consumption is rising more sharply abroad and will continue to do so. Prices in the oil industry in the U. S. probably will increase somewhat, due to higher costs of materials and higher wages. The petroleum industry will make capital expenditures of $6,250,000,000 in the U. S. in 1957. This will be $300 million more than in 1956. See **Page 77. Oil Use to Increase Further in 1957**.....**Herbert Willetts**

☐ **Operations Research has been widely publicized** as an important new management tool. It has been presented sometimes as a magic formula providing near-fabulous improvements in company opera-

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THIS MONTH . . .

tions. Just what is it? How does it work? What can it do? Briefly, it makes more use of scientific methods in solving business problems. It thereby increases efficiency and profits. For more about this live subject, see **Page 80. How Operations Research Aids Management.**
Tage A. Mortensen

☐ **The natural gas industry** and the Federal Power Commission face a difficult problem in connection with fixing of gas prices at the well. The commission must regulate these prices, as directed by the Supreme Court. FPC is expected to adopt the usual rate base method of fixing rates for public utilities. If that method is employed, the commission probably will have trouble determining gas producers' costs and reasonable return on their investments. The problem will be a serious one for the FPC and for natural gas producers. Turn to **Page 89. Fixing Field Prices of Gas Will Be Difficult.**
Dr. Arthur A. Smith

☐ **The current tight money situation** is making it more difficult to carry on drilling or to finance refinery, petrochemical plant, and pipe line construction. Most of the banks helping to finance the oil industry are "loaned up." They are so heavily committed that they hesitate to make new loans. Nevertheless, bankers declare that any worthwhile project still can be financed, although at the higher interest rates that now prevail. Read Changing Panorama, **Page 96. How Tight Money Affects the Oil Industry**. . **H. T. Brundage**

DRILLING ARTICLES

☐ **Here's a new technique** which cuts down on welding and minimizes failures on oil field tubular goods. Discussed are some of the problems involved in field welding. Also outlined for you are the results of an investigation which reveals that some field welding practices actually damage the steel beneath the weld and can cause serious trouble and possible abandonment of a well. Don't miss this article concerning a field method which minimizes such damage. Turn to **Page 135. New Welding Technique Cuts Failures on Tubular Goods** ..... **J. R. Gregath**

☐ **It is possible,** without the knowledge of formation dip to maintain the drilling angle by the proper selection of hole size, collar size, and by the use of proper drilling weights. However, dip information can profitably enter into the proper selection of suitable straight hole drilling techniques. Turn to **Page 140** and read **Usefulness of Dip Information in Drilling "Crooked" Formations** . . . . **Arthur Lubinski and K. A. Blenkarn**

☐ **Here are the working characteristics** of a drilling fluid additive introduced recently by Stanolind Oil and Gas Company . . . mixing ease, stability in high temperature, retarded damage from foreign water or solids contamination and the ability to compound a water-in-oil emulsion or to convert an oil base mud to a water-in-oil emulsion phase. Turn to **Page 150** and read **New Oil Base and Invert Emulsion Muds Introduced** ..... **J. L. Lummus and B. V. Randall**

☐ **Proper selection of wire rope,** correct installation and good maintenance can save you time and money. Here are some calculations that will help you in the selection, stringing-up and cutting-off of wire lines. Turn to **Page 158. How to Select and Handle Wire Rope** ..... **Ty Gibbs**

PRODUCTION ARTICLES

☐ **A petroleum engineer** with the Texas Railroad Commission reviews the techniques of conducting minimum flow rate tests. The conclusions drawn from years of experience will be of interest to every production man in the industry. For details, turn to **Page 171. Your Well's Minimum Flow Rate**..... **G. P. Cokinos**

☐ **Here is an opportunity** for the beginner and the experienced hand to review the basic calculations for proper bottom hole pump and sucker rod selection. This article provides a sound application technique on which to build as your experience and observations warrant. Turn to **Page 176** and learn to . . . **Solve Your Own Pump and Rod Problems**..... **Tom H. Fraser**

☐ **Technical and nontechnical men** working with disposal wells will find something of value in the article beginning on **Page 182.** An easy-to-use chart determines the capacity of disposal wells with various sized tubing. Also included are the how and why of constructing tubing-capacity charts for specific wells. **Effect of Tubing on Disposal Well May Be More than You Think** ..... **F. M. Carroll and G. H. Calhoun**

Turn the Page ▸

THIS MONTH . . .

☐ **A new and accurate approach** has been developed for computing the peak torque on gear teeth of electrically pumped wells. It is based solely on the peak ampere reading. Complete details, a useful data collection sheet, and an amp-torque curve are yours in the article beginning on **Page 191.** Already approved for the operations of some of the major producers, this approach should prove a real help to anyone using electricity to pump his wells. **Simplify Your Calculations** ..... **John C. Slonneger**

☐ **Knowing how to operate** and maintain field equipment results in greater efficiency and profits. The article on **Page 195** provides valuable information for field men operating hydraulic pumping units which reciprocate a sucker rod string connected to a subsurface plunger pump, and to non-counterbalanced and counterbalanced units on compressed gas. **How to Operate and Maintain Hydraulic Surface Pumping Units** **F. C. Cummings**

INTERNATIONAL ARTICLES

☐ **Wartime "scorched earth" damage** has been largely repaired in Indonesia as industry and capital await political stability and clarification of policies in this important and highly complex nation of the east. See **Page 210. Indonesian Politics Holds Key to Future Oil Progress** ..... **By H. T. Brundage**

☐ **Canada's oil and gas position** of importance is assured. Helping to establish this condition has been U. S. money and technical know-how. Turn to **Page 207** for a report on the operations of a sample U. S. company whose future is linked with that of Western Canada. **Phillips Has a Big Stake In British Columbian Operations** ..... **By Anthony Gibbon**

☐ **The British Petroleum Company-**Royal Dutch/Shell Group wildcat on Zanzibar island is drilling ahead. For a quick idea as to the type of exploration and drilling operations under way there, see this pictorial report on the island site of the second deep test drilled in East Africa since exploration began in the area in 1951. **BP-Shell Joint Zanzibar Test Is Drilling Ahead** ..... **Page 218**

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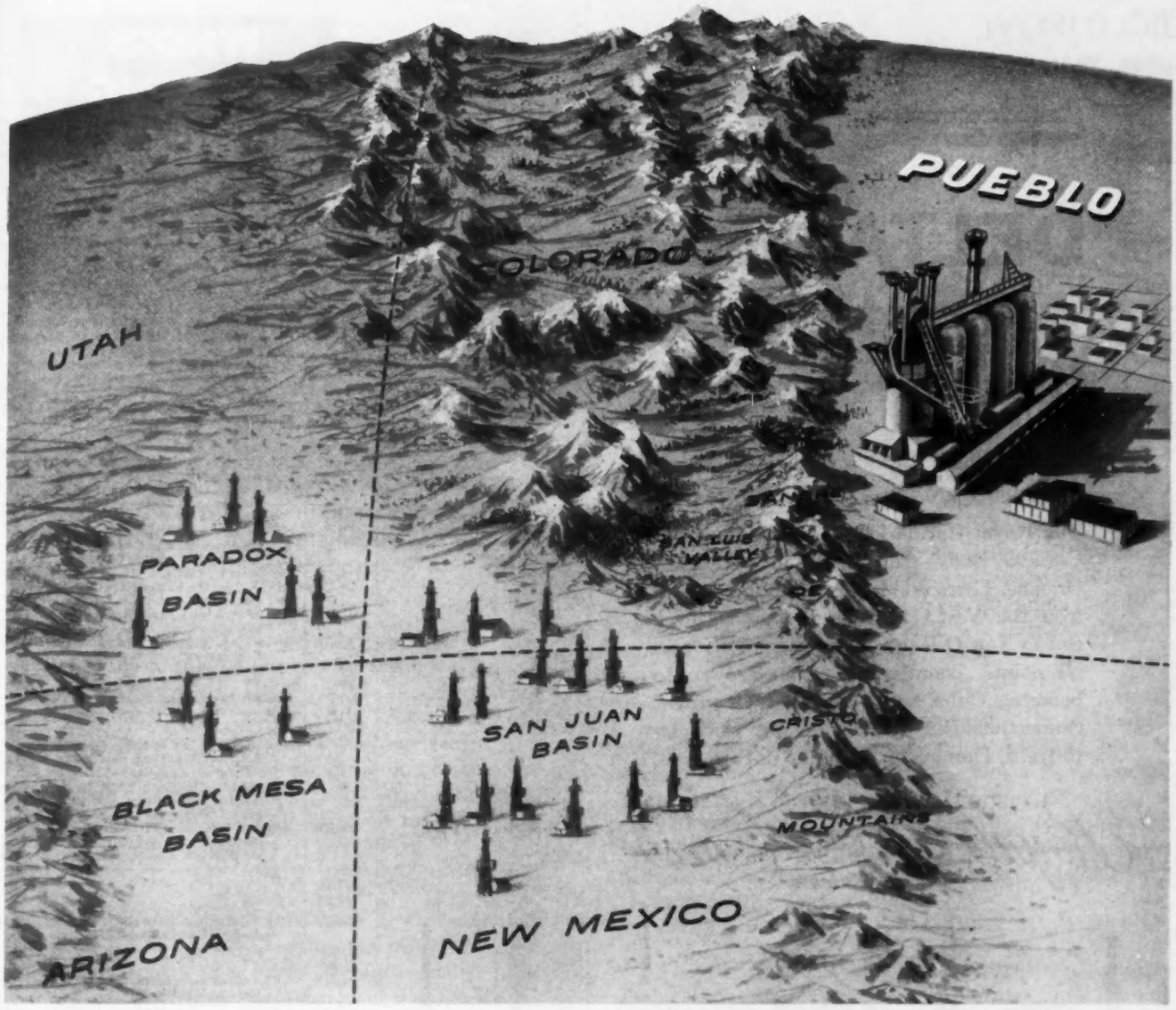

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WHO'S MEETING WHERE

NOV.	
8- 9	American Association of Oilwell Drilling Contractors, 11th Annual Safety Clinic, Statler-Hilton Hotel, Dallas.
8- 9	American Association of Petroleum Geologists, Society of Exploration Geophysicists, and Society of Economic Paleontologists and Mineralogists, Pacific Section, Ambassador Hotel, Los Angeles.
11–14	Society of Exploration Geophysicists, 27th Annual Meeting, Statler-Hilton Hotel, Dallas.
12	Nomads, Annual Luncheon Meeting, Crystal Ballroom, Sheraton-Blackstone, Chicago.
12–15	API, 36th Annual Meeting, Conrad Hilton and Palmer House Hotels, Chicago.
15–16	National Association of Corrosion Engineers Western Region, Fall Meeting, Lafayette Hotel, Long Beach, Calif.
19–20	AIME, North Texas Section, Symposium on Secondary Recovery, Municipal Auditorium, Wichita Falls, Texas.
25–30	American Society of Mechanical Engineers, Statler Hotel, New York.
29–Dec. 15	Indian Industries Fair, New Delhi.
DEC.	
3- 4	New Mexico Oil & Gas Association, Annual Meeting, Alvarado Hotel, Albuquerque, New Mexico.
6- 8	Interstate Oil Compact Commission, Annual Meeting, Fontainebleau Hotel, Miami Beach, Fla.
16–18	Kansas Independent Oil & Gas Association, Annual Meeting, Broadview Hotel, Wichita, Kansas.
1957	
FEB.	
24–28	AIME, Annual Meeting, Roosevelt and Jung Hotels, New Orleans.
MAR.	
6- 8	API, Southwestern District, Statler-Hilton, Dallas.
13–15	Society of Exploration Geophysicists, Hotel Texas, Fort Worth, Texas.
20–22	API, Division of Production, Southern District Meeting, Washington-Youree and Captain Shreve Hotels, Shreveport, La.
APRIL	
1- 4	AAPG, National Convention, Kiel Auditorium, St. Louis.
6–11	Petroleum Equipment Suppliers Association, Palm Springs, Calif.
10–12	API Division of Production, Mid-Continent District Meeting, Mayo Hotel, Tulsa.
16–18	National Petroleum Assn., 54th Semi-Annual Meeting, Cleveland, Ohio.
24–26	API Division of Production, Rocky Mountain District Meeting, Gladstone, Townsend & Henning Hotels, Casper, Wyo.
28–30	Independent Petroleum Assn. of America, Midyear Meeting, Buena Vista Hotel, Biloxi, Miss.

Nomads' Chapter monthly meeting: Los Angeles, second Wednesday, Jonathan Club, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Harry E. Estes, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Hotel Tulsa, Gilbert Swift, Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

Looking Ahead . . .

. . . **Sales in 1957 will exceed those of 1956** in at least several large industries, according to forecasts. Demand for petroleum products is expected to increase over 4 percent—a normal gain. Sales of chemicals are forecast "well above" 1956. The outlook for sales of food products is considered the best ever. Automobile sales are expected to recover substantially after the 1956 decline. Total construction in 1957 will exceed the record volume of 1956, it is believed. Even if residential building fails to exceed 1956, the total promises to increase, due to more industrial and public construction.

•

. . . **World shipping of oil and other commodities probably will never again be so greatly dependent upon the Suez Canal** as it is now. One of the first steps toward reducing dependence on Suez is the U. S. government's current consideration of plans for underwriting construction of possibly 50 new super tankers costing about $1 billion. Giant tankers are proposed as economically feasible for hauling Middle East oil to the U. S. or Europe via South Africa.

•

. . . **Costs of finding and developing new petroleum reserves in U. S.** are expected to increase sharply in the future. Reasons: higher wages, increasing materials and service costs, a greater proportion of dry holes among wells drilled, fewer barrels of reserves developed per oil well, less accessible locations for drilling, as in the ocean, and greater drilling depths.

•

. . . **Because the costs of domestic petroleum are increasing,** the U. S. must consider stepping up its imports of oil from abroad. Ever-expanding U. S. oil consumption cannot continue to be met from domestic sources at today's prices, recently asserted David T. Staples, president, Tidewater Oil Company. The U. S. is facing a decreasing availability of low cost domestic crude, he said. In the next decade or two, he forecast, demand will be far greater than the domestic industry's ability to produce.

•

. . . **Claims that U. S. has reserve oil producing capacity of 2.2 million barrels per day were criticized** by Staples as misleading and probably erroneous. The criticism was as follows. Even if the maximum efficient rate of production today is 2.2 million barrels a day above actual production, this is more than could be produced for a sustained period. The MER of existing fields declines with each day of operation. Furthermore, actual production is falling short of U. S. market demand by 1.1 million barrels daily. (Net imports amounted to that much in first half of 1956.) Without the imports, the reserve capacity of 2.2 million barrels daily, itself questionable, would be cut to only 1.1 million barrels daily.

•

. . . **Even if reserve producing ability is accepted as being 1.1 million barrels daily above market demand,** it is 300,000 barrels a day short of the 1.4 million barrels daily reserve desired by the Defense Department. The department several years ago requested U. S. reserve capacity equal to 15 percent of annual consumption. Domestic demand in 1956 will average almost 9 million barrels daily.

•

. . . **In order to get sound estimates of U. S. oil producing ability** for an extended period, physical tests of fields were suggested by Staples. Under his proposal, tests would be made through cooperation of state conservation agencies, the federal government, and the industry. Important prorated fields would be produced alternately at capacity for 60 or 90 days, then cut back in later months in compensation.

•

. . . **The Pacific Coast area likely will depend increasingly on petroleum imported from Canada and the Far East and Middle East.** Consumption will increase steadily. But West Coast crude reserves and production are not being increased. Production was close to capacity in the first half of 1956. But to meet energy needs, imports of foreign oil averaged over 150,000 barrels daily. Natural gas imported from other states provided energy equivalent to 200,000 barrels of oil daily.

•

. . . **U. S. natural gas pipe line and utility companies expect to spend $7.3 billion** for new construction and expansion of existing facilities in the coming four years, 1956-1959. This will be the greatest four-year expansion in the natural gas industry's history. Vermont is now the only state without natural gas, following recent completion of the 1487 mile pipe line from New Mexico to Oregon and Washington.

•

. . . **Importing liquefied natural gas via refrigerated barges** may be commercially feasible for some industrial nations without indigenous reserves. The American Gas Association reports that gas could be thus imported to London, England, from the Middle East at one-third the thermal cost of manufactured gas, assuming shipment through the Suez Canal.

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Any Monopoly Is Bad

A menacing man-made giant has cast its suffocating blanket of power over American politics and industry. If it is allowed to reach maturity without restriction—one crush of its huge fist could mold the world's greatest economy like putty.

Its name is *labor union monopoly*. Its creators are a comparative handful of men who united 16 million Americans into a single group through the merger of the AFL and CIO.

Even before these two big labor organizations joined together as one—under one roof—there was anxiety about labor union "giantism." A poll conducted by the Opinion Research Corporation showed the public considerably more concerned about bigness in labor than bigness in business.

Despite the feelings of the public, several recent court cases prove that a double standard exists in federal antitrust laws: One under which business monopoly is prohibited—and one under which union monopolistic practices are freed of restraint.

Here are two freedom-jarring examples of what can happen when this nation's courts allow one segment of the public to flaunt the power of monopoly.

•

Labor unions' monopolistic power in politics. Shortly after the big labor union "wedding" last November, President Meany made the following declaration of labor's desire for power: "The scene of battle is no longer the company plant or the picket line. It has moved into the legislative halls of Congress and the state legislatures."

This month marks exactly one year since Meany's political battle cry became public record. And the time is long past due to evaluate the actions his words foretold.

The Committee on Political Education, political arm of the AFL-CIO, is staging an intensive campaign for contributions of $1 each from the organization's members—and for the enlistment of at least 2 million campaign workers.

AFL-CIO is also prepared to divert to political activity the services of more than 60,000 full-time paid union officers—to turn more than 1000 union newspapers, with circulations in the millions, into blatant promotional media for favored candidates—to infiltrate the strong party machines—to organize workers in all of the nation's voting precincts.

Principal objectives of organized labor's electioneering are the elimination of Taft-Hartley restrictions on union leadership activities; repeal of the existing right-to-work laws and the defeat of attempts to extend this protection against compulsory unionism to other states.

Through sheer power of numbers, AFL-CIO has already scored several impressive political victories. Included are the repeal of the right-to-work law in Louisiana last June—and the capture of the state Democratic organization in Michigan.

•

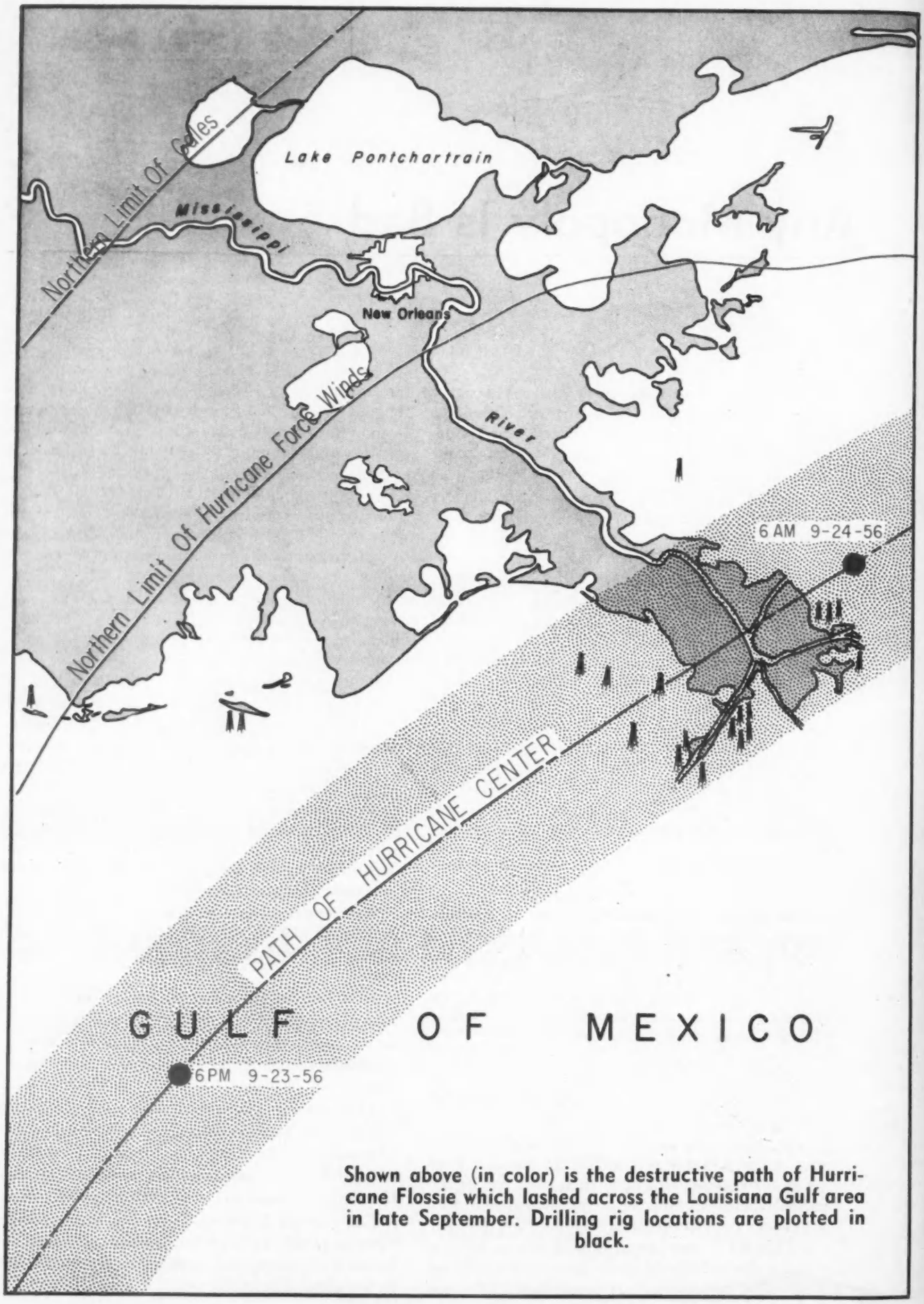
Labor unions' monopolistic power in industry. Because of court protection, labor unions are free to engage in boycotts—to divide territory and exclude business competition—to force employers to deal only with unionized contractors—to dictate what materials and equipment business firms may use—to force work stoppages and plant shutdowns—to drive companies out of business.

Webster defines monopoly as *"exclusive control of anything."* This includes "exclusive control" brought about by labor union power as well as business power.

Is it fair to cut away at one "giant" with a myriad of restrictions, regulations and laws, while at the same time another is allowed the freedom of the law to develop its potential all-enveloping power?

The answer lies with those who make the laws of our country. They alone can put new teeth into the Sherman Act. It should and must deal with *all* monopoly power, whether it be manifested in combinations of employers or combinations of unions.

The warning flag is up. If the new giant ever decides to clench its huge fist, not only will relations between employers and employes be inside—but the nation's free economy as well.



Shown above (in color) is the destructive path of Hurricane Flossie which lashed across the Louisiana Gulf area in late September. Drilling rig locations are plotted in black.

Offshore Operators Look at Flossie's Damage

Flossie gave Louisiana offshore operators their first real hurricane test since drilling activity began in 1947. Here are the operators' reactions to major problems that arose from the storm, including:

- **Amount and type of damage**
- **Evacuation**
- **Storm mooring**
- **Flow gathering line risers**
- **Salvaging unattended vessels**

By DON E. LAMBERT, WORLD OIL Staff

FLOSSIE WAS a fledgling as far as hurricanes go. But when she flicked her skirts at Louisiana offshore operations last September every oil company in the storm area felt the blow of her wrath.

In fact, Flossie's 110 miles per hour winds and 15 to 20 foot waves gave Louisiana offshore operations their first real hurricane test since drilling activity began in 1947.

A WORLD OIL survey of offshore operators reveals the following distribution of losses due to Flossie:

• **Drilling rigs**—relatively small damage, due to design stress geared to much higher winds and wave force.

• **Vessels, mooring line breakage, loss of navigational aids, offshore flow line risers, plus cost of evacuation and towing powerless tenders and barges to port—$3 million.**

• **Shutdown time**—drilling rigs in the path of Flossie (and many outside her path) were shut down from 2½ to 3 days. (See map.) Estimated cost for shutdown time ranges from $2500 a day for a conventional drilling barge to $8500 a day for a deep water drilling platform.

Several hundred offshore producing wells were shut down.

Operators say losses from shutdown will be much higher than the physical damage, particularly when September allowable losses are figured in.

In at least three instances, offshore drilling wells had to be plugged and abandoned. Pipe was bent so badly the operators were unable to continue drilling. Average cost to contractor: $70,000 each.

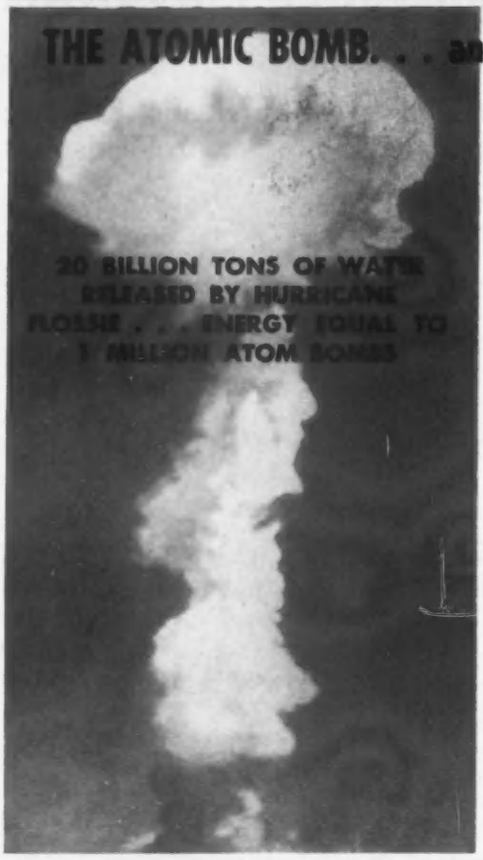
Onshore operations suffered considerably more from physical damage and shutdown time than offshore. More than ten derricks were reported blown down in the Golden Meadows area alone.

What Operators Learned from Flossie. The surveyed offshore companies generally agreed that four major problems arose from Flossie which will be given considerable study in the coming months. The problems and

FREAK DAMAGE WAS COSTLY

The examples of freak damage were almost too numerous to mention. Here are six illustrations of the unusual—and costly—force of Flossie's waves:

- A bird-on-nest rig was moved 18 feet. The well kept it from tipping over.
- Storm tide was 3 to 5 feet on west side of Mississippi River—8 feet on the east side. Eight submergible barges on the east side of the river suffered considerable damage.
- One company had four storage tanks—two 10,000 barrels, one 20,000 barrels and one 30,000 barrels—tear loose and float 100 feet.
- Living quarters were swept off a barge tearing up one-inch concrete floor. Cost: $15,000.
- A drilling rig wallowed in the storm and sank about six feet. Sat down on blowout preventers and bent beams on rotary table floor. Result: Complete overhaul.
- Powerless tender broke its mooring. Tugs arrived too late and it washed aground. One tug rammed the tender and put a hole in its plating. It took eight tugs eight hours to churn it free from the shore. Estimated cost: Over $200,000.


THE ATOMIC BOMB. . . and HURRICANE FLOSSIE
20 BILLION TONS OF WATER RELEASED BY HURRICANE FLOSSIE . . . ENERGY EQUAL TO 1 MILLION ATOM BOMBS

According to the U. S. Weather Bureau, Hurricane Flossie dumped 20 billion tons of water on the U. S. from September 24th through the 27th.

Energy released to the atmosphere by the rain was equivalent to 1 million atom bombs of the Hiroshima type.

Most destructive force from Flossie was the breaking waves and the debris they carried. A cubic yard of water weighs almost 1700 pounds and the waves, driven by the winds, pound at a solid object at the rate of several feet per second.

Flossie's waves averaged about 15 to 20 feet in height—her winds were up to 110 miles per hour in gusts. This compares with previous hurricanes that have hit the Louisiana Gulf with 40 foot waves and 200 mile per hour winds.

operators' opinions concerning each are as follows:

1. Evacuation. Nearly 50 men rode out the hurricane on tenders and other vessels. The men had volunteered on most of the vessels—taking the so-called "calculated risk." No lives were lost, but Flossie was only half the force of other hurricanes that have—and could—hit the Louisiana Gulf area.

Operators say more attention should be given to complete evacuation, doing away entirely with the calculated risk.

2. Anchorage. Types of storm mooring are still a point of discussion between operators. Some reported great success with anchor chains, with no breakage. Others said there was some breakage but the tenders held to their moorings.

One company said all its anchor chains broke while wire anchor lines held fast. The same company reports it is putting two 1500 pound anchors on all its tenders for additional security in future storms.

When the storm hits, the tender will move far enough away from the rig to enable it to swing free in a 360-degree arc—will cast off all lines but the storm anchor. The extra anchor will be put over the side with wire line, ready to drop should the first anchor mooring break or slip.

3. Risers. Offshore flow line risers were an item of considerable damage loss to many companies—while others reported no damage.

One company reporting a large monetary loss from damage to risers said most of the loss resulted from the stairways being located on the same side of the platform as the risers. Waves tore the stairways loose and the debris was driven into the risers.

Another company reporting no damage to risers said its stairways were located on the northwest side of the platform while the risers were on the northeast side.

4. Salvaging Unattended Vessels. Since several tenders and barges were left unattended during the hurricane, operators have expressed concern about the possibility of outsiders salvaging such vessels in future storms.

A WORLD OIL check of marine lawyers in the New Orleans area produced the following opinion on salvaged vessels:

If a vessel is adrift and not under control anyone can board it—make efforts to save it—and bring it into port. However, the salvaging party *has no right to ownership* of the vessel—only a right to salvage award.

Amount of salvage is based on the following factors:

1. Value of the salvaged vessel when brought into port.

2. Value of the salvaging vessel.

3. Nature of the services—whether great hazard to salvaging vessel and crew was involved or just a routine towage.

4. Time involved and expense to which the salvaging party was put.

5. Results accomplished.

All these factors are evaluated and checked with previous court cases of like nature to determine the award due the salvaging party.

If the owner appears to reclaim his vessel, it is his right to do so. However, the salvaging party has right to obtain legal security to protect his salvage claim and that of his crew. Under no circumstances does the salvor or any member of his crew have a right to appropriate anything on the salvaged vessel.

Whenever a vessel is taken for salvage, the owners are advised to contact *only* their insurors and lawyers—and do that immediately.

Company Reports—Circumstances that created the four problems outlined above can best be described by relating experiences of some of the individual companies that suffered damage from the storm. Here is a company-by-company report on losses and storm experience:

Company #1.

Offshore rigs shut down: 6.

Shutdown time for each rig: 3-3½ days.

Amount and type of damage: Two LST's had anchor chain breakage but didn't go adrift. Bow of one ship brushed against side of platform with little damage. Several risers on offshore flow lines broke. One gathering line shifted a little. Jack knife mast came down on one rig.

Experience gained: More study will be given to types of storm mooring. Also ways to cut down on movement of flow gathering lines along the ocean floor. Most companies with offshore lines had movement and experienced damage at connections.

Company #2.

Offshore rigs shut down: 7.

Shutdown time for each rig: 3 days.

Amount and type of damage: Total damage—$180,000. Some of the individual losses included $21,500 damage to tenders—$28,000 damage to rigs—$8000 damage to anchor lines—$12,000 tugboat costs to tow tenders—$22,000 to replace storm anchor—$5200 for helicopter standby—$38,000 total shutdown time.

Experience gained: Company #2 is planning to put storm shutters on windows of its tenders. Had at least one window broken by waves.

Don't leave anything heavy that can roll around on deck of a tender. Had blow out preventer that rolled around and creased the deck.

Company #3.

Offshore rigs shut down: 20.

Shutdown time for each rig: 3 days.

Amount and type of damage: $425-450,000 over-all damage. Platforms and barges stood up well. No damage to drilling equipment. Two tenders were in path of storm. One pulled anchor and headed into the Gulf out of the storm. The other rode it out using anchor chains.

Company #4

Offshore rigs shut down: 3.

Shutdown time for each rig: One down two days—one down 7 days—one down 19 days.

Amount and type of damage: Shutdown costs ranged from $3000 to $3500 a day for each rig. No report on over-all damage.

Experience gained: Helicopters are the most practical way to evacuate, particularly in transferring injured personnel ashore.

Company #5

Offshore rigs shut down: 8.

Shutdown time for each rig: 3 days.

Amount and type of damage: Lost $4000 radio antenna and 20 navigational aids for wells worth about $800 each. Barge and speedboat were washed aground.

Company #6 (Onshore)

Number of rigs shut down: 15.

Shutdown time for each rig: 13 were shut down 48 hours—one was down two weeks—another four weeks. There was $200,000 damage to one rig alone. **—The End**

Better Management of Oil Inventories Is Needed

• Gasoline stocks have been built to excessive levels in spite of knowledge that surplus was accumulating.

• This year has brought repetition of "the same old story" of previous years when refinery runs and stocks were not balanced with market demand.

• Management deserves credit for establishing reserve operating capacities to guard against emergencies. But it needs to develop skill to avoid temporary surpluses that hurt the industry.

By L. F. McCOLLUM, President,
Continental Oil Company
Houston

THE OIL INDUSTRY urgently needs better inventory management. We have not found the means of maintaining a fully satisfactory short-term relationship between refinery runs, stock positions, and current demand. Driven by the pressures of competition and our zeal, each to outdo the other, we are often inclined to carry more products into inventory than a prudent, realistic size-up of economic facts would indicate is warranted.

Inventory Management. The problem of short-term inventory management has become increasingly complex in recent years, largely because of fundamental changes in the seasonal pattern of demand. Not long ago, the combined demand for all petroleum products was nearly constant throughout the year. The summer bulge in gasoline demand was approximately balanced by the winter bulge in heating oil consumption. More recently, however, gasoline sales have run nearly as high in the winter as in the summer, a natural result of the improvements in highways and automobile performance. Meanwhile, the winter demand for heating oils has steadily increased. As a result, the demand for petroleum products now reaches a sharp seasonal peak during the month of January.

The changes which have taken place in the seasonal pattern of demand are illustrated by the fact that this year the combined demand for all products in May was 15 percent less than in January; 10 years ago, in 1946, the difference between the two months was only 2 percent. This seasonal downswing in mid-year demand must be taken into account at all levels of the oil industry, beginning with crude oil production. Unless this is done, excess stocks will accumulate, and the price structure for products, and perhaps even crude oil, may be undermined.

Past Year. The events of the past 12 months provide a particularly vivid illustration of the urgent need for more prudent inventory management

on the part of the nation's refiners.

At this time a year ago, stocks were in excellent shape, with one noteworthy exception in the case of distillate. Gasoline stocks were almost precisely at the same level as a year earlier. Inventories of crude oil and residual fuel oil were 16 million and 10 million barrels lower, respectively, than on October 1, 1954. Distillate stocks, however, were uncomfortably high—a full 15 million barrels above the level of the previous year.

Fortunately for the industry, the weatherman stepped in and brought us the first really cold winter in several years. With this assistance, distillate stocks were brought to satisfactory levels before the end of the year. The demand for distillates proved so strong, in fact, that increased refinery output became necessary. The refiners rose to the occasion, but met the situation mostly by increased refinery runs rather than by higher distillate yields. While solving one problem, therefore, we created another for ourselves in the form of an over-accumulation of gasoline stocks.

Here are the unpleasant statistics. Refinery runs in the fourth quarter of 1955 were about 9 percent above those for the corresponding period of 1954, and we wound up the year with 10 million barrels more gasoline on hand than at the end of the previous year.

Enthusiasm in 1956. Gasoline demand remained surprisingly strong, and hence no one became much alarmed about the high stock levels. The industry's refineries moved into the new year with runs at an all-time high and established a new record for refinery runs in January, 1956. During the first quarter of 1956, refinery runs were almost 9 percent higher than in the first quarter of 1955, and by the end of March, gasoline stocks were up 16 million barrels over the previous year.

These high stock levels clearly suggested that caution was in order. But our competitive enthusiasms blinded us to economic facts. During the second quarter of 1956, refinery runs were about 7 percent ahead of the same period in 1955. By June 30, gasoline stocks were 20 million barrels, or 12 percent, above the level reached on the same date in 1955.

The pattern set early in the year has been continued. For the year to date, gasoline demand has been strong —up almost 5 percent from last year. The strong gasoline demand, coupled with good gains in distillate demand, has brought about an increase of about 5.2 percent in the total demand for all products. No cause for complaint here! But refinery runs so far this year are up almost 7 percent over last, as compared with the 5.2 percent gain in total demand. (Data are as of Sept. 14, 1956.)

It is not surprising, therefore, that the industry now finds itself with almost 24 million barrels more gasoline in storage than it had at this time last year (September 14). The summer is over, and there is little hope that these stocks can be brought to reasonable levels before the end of the year. The urgent need for reductions in refinery runs is illustrated by the fact that if runs and yields remain at their present levels and demand develops in accordance with Bureau of Mines forecasts, gasoline stocks by December 31 will be 27 million barrels higher than at the end of 1955.

The present gasoline stocks hang heavily over the market, and future events will reveal the economic consequences of such an over-accumulation of inventories.

Past Mistakes. If our present difficulties from overexuberant output and top-heavy stocks were unique, they might be passed over lightly as a first offense against the law of supply and demand. But a scanning of the record shows there is nothing novel about our present situation. Looking back over the years, it is apparent that we have steadfastly refused to learn from our experience.

In the winter of 1948-1949, we suffered severely from declining refined product prices because we failed to reduce refinery runs and to adjust yields and stock positions in accordance with changing conditions in the markets for distillates and residual fuel oil.

In 1951, the penalties for accumulating excessive stocks were avoided in the coastal areas only because Iranian oil happened to drop out of the world supply picture. We were not so fortunate in the Mid-Continent area, where real price weaknesses developed.

Early in 1952, we were well on the road toward a colossal pileup of stocks, but once again we were saved by outside forces. This time it was the series of refinery strikes in May which forced a sharp reduction in refinery runs and thus brought stocks to reasonable levels.

Same Old Story. Each year seems to be another version of the same old story. In the fall of 1953, we once again accumulated oversupplies of gasoline and distillate. The winter demand for distillates was, fortunately, sufficient to bring stocks to reasonable levels by March of 1954. No such help was forthcoming in the case of gasoline, and declines in prices occurred in June and July—a time when gasoline demand is usually strong.

In view of these repeated experiences in the past, it is particularly distressing that we should once again be facing the potential consequences of unwise inventory management. We have seen time and again the excellent job this industry can do when it is called upon to produce in times of economic or military emergency. An equally important measure of our management ability is how well we can restrain our optimism in times of oversupply. Our performance in this regard puts me in mind of a teenager driving a hot-rod. Jackrabbiting out when the signal changes, burning rubber by the yard. And for what?—Only to wait out the red light down at the end of the block!

The reserve producing capacity and flexibility in refining, transportation, and marketing facilities, which we have striven so hard to establish, can be of great value to us in times of economic or military emergency. But they can also be a source of painful, periodic gluts and disruptions in the refined products markets—unless we develop the managerial skill to keep refinery runs and inventory positions in reasonable balance with seasonal changes in market demand.

ACKNOWLEDGMENT

From an address before the Texas Mid-Continent Oil and Gas Association, Houston, Oct. 2, 1956.

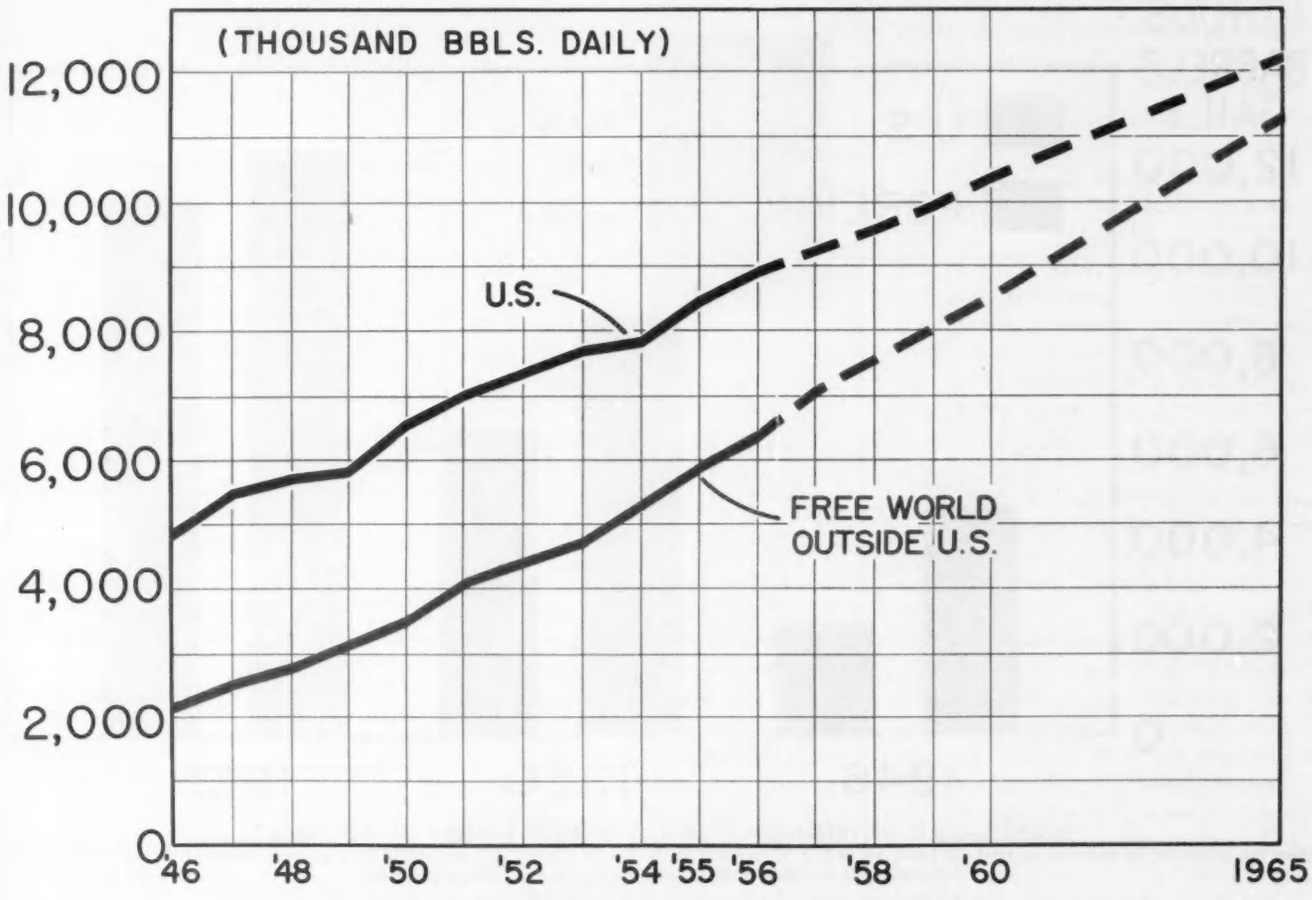


FIGURE 1—EVERY YEAR BRINGS GROWTH IN OIL CONSUMPTION
Sales of petroleum products are increasing steadily in U. S. They are rising even more sharply in free world outside U. S.

Oil Use to Increase Further in 1957

FORECASTS FOR 1957:

- **U. S. consumption will increase 4.3 percent after 5.4 percent gain in 1956.**
- **Sales in Free World outside U. S. will continue sharp rise.**
- **Oil prices will go up somewhat because of higher costs and wages.**
- **Industry's capital outlays in U. S. will exced $6.2 billion.**

By HERBERT WILLETS
Socony Mobile Oil Company
Nek York City

CONSUMPTION OF all petroleum products in Continental U. S. probably will average about 9,246,000 barrels daily in 1957. This will be an increase of 4.3 percent over 1956. The sales of 8,867,000 barrels daily estimated for 1956 will be 5.4 percent above 1955.

Consumption has been increasing more sharply in other Free Countries than in the U. S. and will continue to do so.

U. S. demand for gasoline is expected to be 4.2 percent greater in 1957 than in 1956. Anticipated increases for other products include the following: distillate fuels 4.5 percent, jet fuels 12.2 percent, liquefied petroleum gas 7.8 percent, lubricants 3.3 percent, kerosine 0.3 percent, residual fuels 0.1 percent.

Prices in the oil industry in the U. S. probably will increase somewhat in 1957, due to higher costs of materials and higher wages.

The petroleum industry is expected to make capital expenditures of approximately $6,250,000,000 in the U. S. in 1957. That would be $300 million more than in 1956.

Past and Future. This study deals primarily with the sales outlook for 1957. But it also offers briefly some

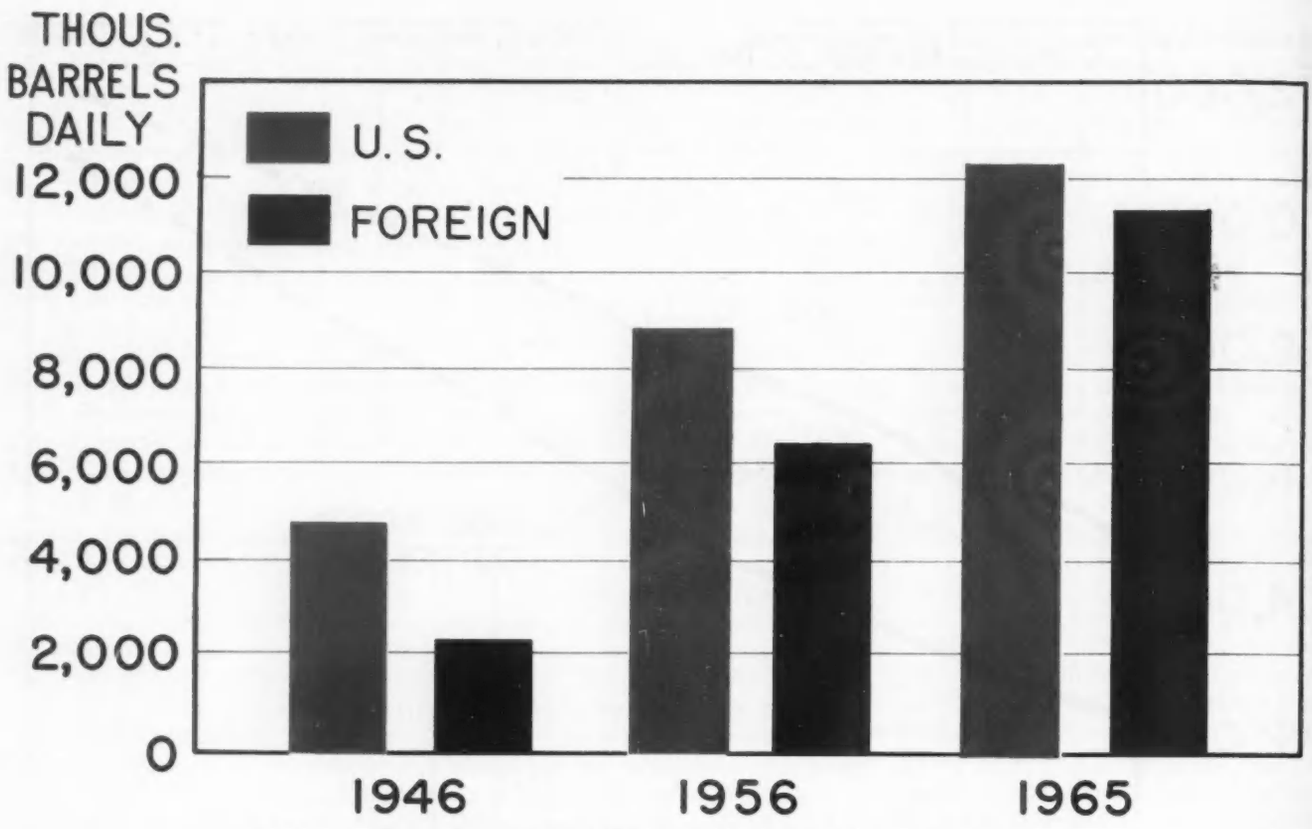


FIGURE 2—SALES OF PETROLEUM PRODUCTS INCREASE SHARPLY IN EACH DECADE
Sales are expected to increase in next 10 years by nearly 50 percent in U. S. and almost 100 percent in foreign free countries. In past 10 years the sales virtually doubled in U. S. and tripled in the foreign countries.

historical figures and some projections beyond 1957.

Domestic Sales. The top curve of Figure 1 shows sales—more precisely, consumption—of petroleum in continental U. S. from 1946 through 1955, an estimate for 1956, and projections through 1965. The curve pretty well speaks for itself. But three comments on it may serve to point up the story of the industry's growth. First, there has been an increase in sales each year, and these annual increases likely will continue. Second, sales for 1957 are expected to be about double those for 1946. Third, domestic sales in 1965 probably will be more than two and a half times those for 1946.

Sales Abroad. Before getting into detail on the domestic sales outlook for 1957, a quick look at some figures on petroleum sales abroad is offered. The lower curve of Figure 1 shows sales in foreign countries outside the iron and bamboo curtains. As illustrated by this curve, in 1946 these foreign countries consumed about half as much oil as the U. S. But sales are growing quite a bit faster abroad than at home. By 1965, the free foreign countries probably will be using almost as much oil as the U. S. and five times as much as they used in 1946, the first full year after end of the war.

There are two reasons for mentioning these foreign figures in comments that otherwise are limited to the domestic picture. One is that much of this rapidly growing foreign demand is being supplied by affiliates and subsidiaries of American companies. The other is that this growth in the use of oil is indicative of the economic development of countries with which the U. S. has considerable trade. This development is bound to have a substantial effect on many American industries other than oil.

U. S. Use in 1957. Turn back now

TABLE 1—Sales of Petroleum Products in Continental U.S.A.
(THOUSANDS OF BARRELS DAILY)

Product	1955	1956	% Dif. '55-'56	1957	% Dif. '56-'57
Gasoline	3621	3792	+ 4.7	3953	+ 4.2
Kerosine	320	310	— 3.1	311	+ 0.3
Distillate Fuels	1593	1705	+ 7.0	1781	+ 4.5
Residual Fuels	1527	1543	+ 1.0	1544	+ 0.1
Jet Fuels	154	222	+44.1	249	+12.2
Lubricants	116	120	+ 3.4	124	+ 3.3
Asphalt & Road Oils	255	279	+ 9.4	308	+10.4
Liquefied Pet. Gas	391	450	+15.1	485	+ 7.8
Other Products	438	446	+ 1.8	491	+10.1
Total	8415	8867	+ 5.4	9246	+ 4.3

TABLE 2—Capital Expenditures by Petroleum Industry in U.S.A.
(MILLIONS OF DOLLARS)

Division	1955	1956	% Dif. '55-'56	1957	% Dif. '56-'57
Producing	$4100	$4200	+ 2.4	$4400	+ 4.8
Refining and Chemical	835	900	+ 7.8	950	+ 5.6
Marketing	375	480	+28.0	510	+ 6.2
Transportation	240	305	+27.1	325	+ 6.6
Other	50	65	+30.0	65	.....
Total	$5600	$5950	+ 6.2	$6250	+ 5.0

to the domestic sales outlook in the oil industry for 1957. Table 1 shows, for nine categories of products, actual sales in 1955, estimates for 1956, and projections for 1957.

Gasoline Sales. Gasoline is the largest of these categories. The industry is expected to sell about 4 percent more gasoline in the U. S. in 1957 than in 1956. The principal reason for the increase is that there will be between 3 percent and 4 percent more vehicles on the road next year than there are now. For the first time since a tailor-made gasoline was developed for aviation purposes, there is not foreseen a continuing upward trend in aviation gasoline sales. Because of the switch by the military from piston engines to jet planes, aviation gasoline sales probably will not increase in 1957. This has very little effect on the percentage of increase in total gasoline sales, however, because aviation gasoline amounts to less than one-sixteenth of the total.

Kerosine sales will change very little, if at all.

Distillate Fuels. The distillate fuels category is made up primarily of diesel fuel and the oil used in home furnaces. Diesel fuel use has enjoyed an exceedingly rapid growth for a number of years, due mainly to dieselization of railroads. With the railroads now almost completely dieselized, diesel fuel sales are expected to gain only about 4 percent in 1957.

Despite the large gains in use of natural gas for home heating, distillate fuel continues to make respectable increases in this country. There probably will be 7 percent more oil burners in use in 1957 than in 1956. With oil burners more efficient and with houses better insulated and somewhat smaller, however, the increase in heating oil sales seems likely to be a little less than the increase in the number of burners—probably 5 percent to 6 percent over 1956. Consumption of heating oil is, of course, greatly affected by weather. Normal weather is assumed in making this forecast.

Residual Fuel. As for residual fuel oil, the heavy oil used mostly as an industrial fuel, little change is likely, primarily because additional supplies probably will not be available. As refining processes have improved, U. S. refiners have been making a decreasing percentage of residual, which, as the name implies, is the least valuable product.

About the Author

HERBERT WILLETS, vice president and director in charge of domestic marketing for Socony Mobil Oil Company, Inc., began his career with the company June 18, 1923, upon graduation from Union College at Schenectady, N. Y. His training in the marketing of petroleum products began as a clerk in the Tank and Pump Department. He became successively a junior salesman, a general salesman, and district marketing assistant in service station work. He was then made assistant district manager in Troy, N. Y., his native city, and Utica, N. Y. Willets next became manager of the Buffalo District, then was advanced to assistant manager of the Lakes division at Buffalo. Later he was appointed manager of the Philadelphia division, and following that, he moved to New York as manager of the New York City division.

In 1945 Willets was assigned to Socony-Vacuum headquarters at 26 Broadway, New York, first as assistant and then as manager of the Eastern marketing region. He later became manager of the Central marketing region and in 1947 was named general manager of Domestic marketing. He was elected a director Dec. 4, 1951.

Jet Fuel. Higher military demand is almost entirely responsible for the forecast of a 12 percent increase in jet fuel sales. However, jet fuel still accounts for less than 3 percent of total oil product sales.

The recent passage of the highway bill may result in a higher demand for asphalt in 1957 than the figure listed.

The 1957 estimates assume that there will be no major change in the international situation and that industrial activity and the general economy of the country will improve moderately next year over this year's levels. There has been no attempt to show the effect of any major supply problem resulting from the Suez Canal crisis.

Prices May Rise. Higher costs of materials and payroll plus the costs of quality improvement probably will mean a somewhat higher price level in the oil industry next year. In the past three years, truck prices have gone up 10 percent, metal and metal products 11 percent, and average wage and related costs 20 percent. The government's index for wholesale prices shows industrial products are up 6.5 percent. During that same period, from August 1953 to August 1956, the average wholesale price of heating oil was up about 5 percent. But gasoline prices, excluding taxes, actually increased only one-half of 1 percent. Federal and state taxes on gasoline, incidentally, now average 8.8 cents a gallon, which adds 53 percent to the price of gasoline at the wholesale level.

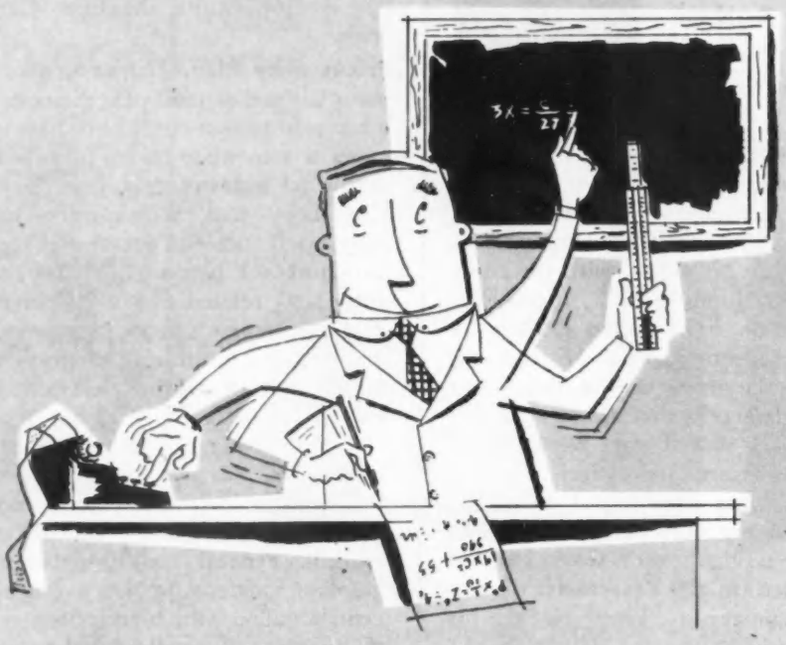
During the past few years the industry has been plagued by a number of gasoline price wars. In some localities they have been both prolonged and very severe. They have been costly to both dealers and suppliers and in most instances have had no realistic economic base. There are some indications that these wars are abating. But the possibility of excessive gasoline stocks going into the winter is causing concern. Nevertheless, there is reason to think that there is increasing realization in the industry that uneconomic price cuts do not solve the problem of meeting rising costs.

Capital Expenditures. Table 2 shows capital expenditures of the oil industry in the U. S. Despite the record level of capital spending last year, it is expected to be higher this year, and still higher next year. The figure of $6 billion plus for 1957 is almost half again as much as the industry's domestic capital expenditures only four years ago and more than double those of six years ago. This may show how the oil industry's activities may affect the economy in general and other industries in particular.

ACKNOWLEDGMENT

From remarks at a meeting of the National Industrial Conference Board in New York City September 21, 1956.

Answers to Some Questions About OPERATIONS RESEARCH



What is it?

It consists of scientific research methods applied to the solution of practical operating problems in industry and business. (It also is used in military, governmental and other activities.)

What can it do?

Various techniques enable management to predict future profits under certain courses of action or other effects of different conditions acting at the same time.

How does it work?

Rational solving of problems is traditional in business. Systematic experiments in operations also have been common. Operations Research adds theoretical reasoning. Use of theory increases the range of predictions that can be made on the basis of data involved.

Is it new?

It contains some of the elements of industrial engineering, business research, and applied statistics. But it makes more extensive use of theory and verification of theory by experiment than do earlier methods. Though used earlier, it has come into greatest prominence in the past several years.

How

By TAGE A. MORTENSEN
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ALMOST EVERYONE has heard of operations research—OR—and seen it labeled as a new management tool. Some companies were using it, or elements of it, before the term was coined. It has, at times, been presented as a magic formula, a wonder drug, effecting near-fabulous improvements in company operations. So, alert management will ask: How does it work and what can it do? What does it cost? Is it basically different from other management services? And how do we go about using it?

These questions have been pondered in technical papers, seminars and symposia during the last few years, and the host of answers given has covered quite a bit of territory. They have sometimes been contradictory answers. This is to be expected; the questions have been general, and hence difficult to answer without undue use of *if's* and *but's*. Questions also have been philosophical, leaving room for many different (but equally true) formulations of answers.

But a fairly solid description has emerged of the main characteristics of operations research. A suitable definition may be that **operations research is the use of the scientific method, as it is developed by the physical sciences, on a new subject, operations.** Whereas earlier research has been done on things, OR is research on *what is done with things.*

That research methods of the physical sciences are potent ones cannot be disputed; they have been a

Operations Research Aids Management

It makes more use of scientific methods in solving business problems. It thereby increases efficiency and boosts profits.

prime factor in the tremendous advances in our technology. The question of whether these methods will be equally applicable to business and industrial operations is therefore well worth considering.

Philosophy and Principles. Main object of physical research is explanation of events in simpler terms. The basic tenet behind this is that there exists a cause-and-effect relationship, so that the same cause will, under equal conditions, always produce the same effect. The researcher strives to express the basic cause-and-effect relationships numerically in terms of general laws which may be used to determine the combined effect when several causes act simultaneously, and to predict the course of future events of similar types.

Policy for this research is dominated by two elements which continually interplay: *experiment and theory*. With most persons favoring practical views rather than abstract reasoning, beginning of an investigation is most often experimental; that is, producing, repeating and observing events in question under controlled conditions and classifying the outcome. It produces reliable, but spotty, information within a limited set of boundaries (depending on how extensive the experimental series is). Possibilities for erratic behavior exist, of course, even within the test limits, and the experiment by itself is of modest value for predictions outside these limits.

Enter here theory. To begin with, it is tentative, it is a hypothesis which is accepted until contradicted. It is an abstract formulation, expressible in mathematical equations, of the laws thought to govern events in question.

The scientist will immediately set up experiments in which he will make conditions as embarrassing and awkward as possibe for his new hypothesis by making the experiments cover the most extreme cases. More often than not this will uncover weaknesses in the hypothesis, and the scientist will modify it until agreement is reached between experiment and hypothesis. He will then start over again on a new cycle for further refinements.

Somewhere during this work, the hypothesis will have matured into a theory which can be accepted as proven and substantiated over a very large range of conditions. Thus, by enlisting the services of theory, the value of the spotty experimental knowledge has been increased many fold. Predictions in the form of interpolations and extrapolations from the data can be made without fear of loopholes in the formulated general laws. This must be emphasized. Although the experimental and empirical part of an investigation is the one which is most easily followed and understood, it is the theoretical and abstract part which multiplies the range of application of the data, and which guards against unexpected kinks in the behavior of the things investigated.

In business and industry, rational solving of problems has been used as long as business itself has existed. Systematic experiments on operations have been made. However, additional use of theoretical reasoning—or, to employ a fashionable term, of *mathematical models*—is one of the characteristics of operations research.

Admittedly, this thrust of theoret-

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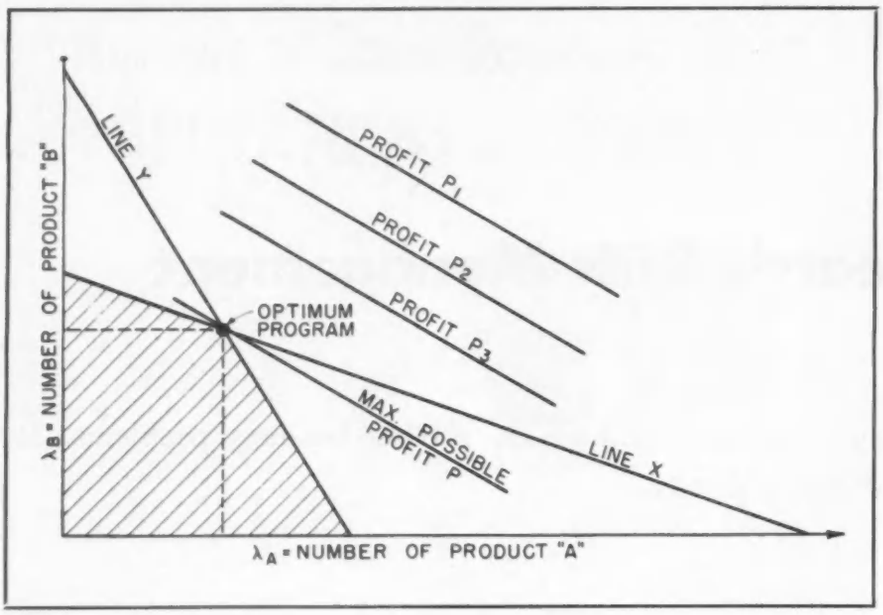

A production problem solved by a graphical method . . .

A manufacturer has limited supplies of two raw materials. He is making two products. His problem: How many of each should he make to get maximum profit and still be within limits of the raw materials? The answer is indicated at the point (large dot) labeled "Optimum Program." The theoretical reasoning or mathematical model here employed is linear programming. Mathematical computations increase the range of predictions that can be made on the basis of the data involved. This is a relatively simple problem. Similar solutions are possible for much more complex problems, involving many more variables.

ical tools into business problems will not be as extensive as in the physical sciences; too many factors (such as human behavior) are beyond analytical and numerical formulation. Yet, mathematical models have had enough startlingly successful applications to operations to spark continued efforts for further use.

Once the model has been established, it is used for *dry runs,* giving readily different consequences of various actions or strategies; the consequences in this case meaning profit, return on investment, or whatever yardstick is being used in the model. Thus it furnishes information to aid management in reaching decisions concerning these actions—the management decisions being the causes, the model showing the effects—to the extent that the significant variables can be drawn into the analysis. This has contributed to a very important aspect of operations research: *its broadness of view.*

An OR study may be confined initially to one department of a company, but by its very nature, it will point out significant causes located in other departments of the company, if any. And so, quite often, a study will eventually be carried out on a higher level than when originally formulated, and its scope will be company-wide rather than department-wide.

If it is agreed that OR tends to give, as fully as possible, a picture of the consequences of various business strategies and a ranking of them, and if it is agreed that the viewpoint of OR is company-wide, one may ask: Will operations research tend to replace management? The answer is no, it will not.

Questions of psychology, morale, politics and ethics enter into all significant business decisions. These factors probably will always be outside and above any mathematical formulation of a problem. Yet they must be considered before management can possibly make sound decisions.

What operations research can do is to recognize and solve problems of a routine or repetitive nature. Its causality basis implies repetition. And the often extensive effort required in applying OR techniques makes it feasible to use the method only when the repetitive nature of the problem warrants such an initial effort.

Hence, OR should be considered a means of eliminating drudgery of routine decisions, leaving management free to cope with those situations which require experience, intuition and leadership for their solution, a means for leaving management free to manage.

Methods and techniques. The foregoing has concerned the general philosophy and principles of operations research. Technical literature gives extensive coverage of this subject[4-1], as well as that of techniques and methods.

Now take a closer look at the use of mathematical models and the ingredients from which they are made. One of these is linear programming,[5,6] a technique which can determine the best solution to allocation problems where a number of processes (for example production or promotion activities) are competing for limited amounts of various resources (for example raw materials, machine tool time, or capital), provided all relationships are linear combinations.

Consider the following illustration: A manufacturer has two products, A and B. They are produced from the raw materials X and Y, which enter into A and B in different amounts per item produced. Total resources of X and Y are limited. The manufacturer may ask for a production program, that is, how many items A and how many items B he should produce to make a maximum net profit and, of course, still be within the raw material limits.

Let:

- λ_A be the number produced of product A
- λ_B be the number produced of product B
- a_{XA} be the amount of resource X going into each item of product A
- a_{XB} be the amount of resource X going into each item of product B
- a_{YA} be the amount of resource Y going into each item of product A
- a_{YB} be the amount of resource Y going into each item of product B
- c_A be the net profit on each item of product A
- c_B be the net profit on each item of product B
- b_X be the maximum amount of resource X available
- b_Y be the maximum amount of resource Y available

The unknown numbers λ_A and λ_B

are to be determined so that the profits P are maximized. This may be written as

$$P = \lambda_A \cdot c_A + \lambda_B \cdot c_B = \text{maximum} \quad (1)$$

The limitations are

$$\lambda_A \cdot a_{XA} + \lambda_B \cdot a_{XB} \leqq b_X \quad (2)$$

and

$$\lambda_A \cdot a_{YA} + \lambda_B \cdot a_{YB} \leqq b_Y \quad (3)$$

In the first of these inequalities, the left side represents the amount of raw material X which is used, consisting of $\lambda_A \cdot a_{XA}$ into product A and $\lambda_B \cdot a_{XB}$ going into product B. This, of course, must not exceed the amount b_X available.

Similarly, the left side of the second inequality represents the amounts of resource Y going into products A and B. This must not exceed the amount b_Y available.

Further, since the manufacturer cannot produce a negative number of items A and B:

$$\lambda_A \geqq 0 \qquad \lambda_B \geqq 0 \quad (4)$$

The above is a standard formulation of a linear program, in this case in two dimensions.

This case can be solved readily by graphical methods, as illustrated by Figure 1. The figure represents the first quadrant in the λ_A-λ_B-plane. Thus each point represents a certain manufacturing program.

If the less-than sign in inequality (2) is omitted, there results an equation which may be represented by the line X on Figure 1. All points satisfying inequality (2) must therefore lie below the line X. Similarly, all points satisfying inequality (3) must lie below or on a certan line, drawn as line Y in the diagram.

All points (representing all manufacturing programs) satisfying simultaneously requirements (2), (3), and (4) must lie within (or on) the lines X, Y, and λ_A- and λ_B-axes. This area is shown hatched in the figure.

Of the possible programs there now remains to select the one (or those) that will give maximum profit. If P in equation (1) is a constant, the expression represents a straight line. To different profit values there corresponds a family of parallel straight lines, located so that the higher the value of P, the higher the corresponding line. This is illustrated by the lines P_1, P_2, and P_3 in the figure.

As shown, it is evident that the highest possible value of P is determined by "moving" a profit-line downward until it touches the nearest point of the hatched polygon. This determines the maximum profit as well as the manufacturing program (that is, λ_A and λ_B) by which this profit is obtained.

Principle of the above method can be used on problems with any number of resources and products. Only the volume of computations limits the size of problem which can be handled. Similarly, the method can be used on problems of quite different appearances: Transportation problems, promotion problems, personnel assignment problems and inventory problems.

One early application was to the problem of gasoline blending in a refinery. This is described in detail in a paper by A. Charnes, W. W. Cooper and B. Mellon.[7] The following exposition is based on their paper.

Objective was to determine an optimum program for blending of straight-run gasolines, catalytically cracked gasoline, and certain chemical additives into aviation gasolines and premium automotive gasolines of given specifications. Basis for using the linear programming technique is that the desired specifications can be considered linear combinations of those of the components in the blend.

The study deals with a case in which four types of gasolines are to be blended from input components. The specified properties are performance numbers (P.N.) and Reid Vapor Pressure. The number of variables to be considered was limited by the fact that no high-speed computing equipment was to be used. Refinery policy dictated that the input components be used at given rates to eliminate need for additional tankage for these stocks.

The input components, their specifications and rates are listed in Table 1. Blended products and their speci-

TABLE 1
Aviation Gasoline Stocks

Symbol	Component	Specified Usage Bbls/Day	R.V.P.	BLENDING INDICES: P.N., Test 1-c, TEL cc/gal =0.5	P.N., Test 1-c, =4.0	P.N., Test 3-c, =4.0
A	Alkylate I	3,800	5.0	94.0	107.5	148.0
B	Cat. Gasoline A	2,652	8.0	83.0	93.0	106.0
D	Straight Run Gas A	4,081	4.0	74.0	87.0	80.0
F	Isopentane	1,300	20.5	95.0	108.0	140.0

TABLE 2
List of Products

GASOLINES: Symbol	Aviation Grade	SPECIFICATIONS: Maximum R.V.P.	Maximum P.N., Test 1-c	Minimum P.N., Test 3-c	Maximum TEL,cc/gal
M	80L	7.0	80.0	....	0.5
N	91C	7.0	91.0	96	4.0
Q	100C	7.0	100.0	130	4.0
Z	Premium Motor	*)	*)	*)	3.0

*) No bearing on computation since this gasoline is blended to specifications with other components.

TABLE 3
Inputs and Outputs (in Bbl/Day) for Optimum Program No. 1

Input \ Output	M	N	Q	Z	Total
A	....	60	3,740	....	3,800
B	....	....	2,652	....	2,652
D	....	3,023	1,058	....	4,081
F	....	653	534	113	1,300
Total	....	3,736	7,984	113	11,833

TABLE 4
Inputs and Outputs (in Bbl/Day) for Optimum Program No. 2

Input \ Output	M	N	Q	Z	Total
A	....	....	3,800	....	3,800
B	....	1,279	1,373	....	2,652
D	....	2,111	1,970	....	4,081
F	....	347	840	113	1,300
Total	....	3,737	7,983	113	11,833

fications are listed in Table 2. The tables refer to two test conditions, 1-c and 3-c, which correspond to a rich (take-off) and a lean (cruising) mixture, respectively. Throughout the problem it is assumed that the maximum amount of tetraethyl lead (TEL) is used.

The yardstick, or measure of effectiveness, to be used for judging the value of any blending program is total net receipts. These are obtained by using suitable market prices for each of the four blends M, N, Q, and Z, and subtracting cost of the TEL from gross receipts. All other costs are considered fixed, and hence of no influence on the blending program.

Summing up, the problem may be stated as follows: With given volumes of the input stocks A, B, D, and F (as listed in Table 1), find the optimum blending program for the products M, N, Q, and Z (as listed in Table 2); that is, the program which results in maximum net receipts.

The problem was formulated in exactly the same manner as the simple two-dimensional example. The blending problem as stated required 10 equations (or inequalities) in 22 unknowns. It was solved by means of the Simplex Method, a systematic procedure developed by G. B. Dantzig.[6]

Initially only test condition 1-c was imposed. Two independent optimum programs were found. They are listed in Tables 3 and 4. Any linear combination of these two programs will, of course, also be an optimum program. The solutions obtained were in agreement with independent program calculations for the same problems made by company officials.

As explained earlier, once set up, the mathematical model can be used for dry runs, determining the effects of various changes in conditions. This programming model was used to investigate the changes in net receipts produced by: (a) using the more strict test combination 1-c and 3-c instead of 1-c alone; (b) a policy requirement that exactly 500 bbl./day be produced of product M; (c) a policy requirement that at least 500 bbl./day be produced of product M; and (d) changes in the blending characteristics of the input, such as reduction of the R.V.P. and octane rating.

Likewise, the model could have been used to investigate the consequences of changing the fixed volumes of input stocks to be used in the blending.

Calculations show that some of the changes produce only slight changes in net receipts (but at times with considerable detail changes in the program), while others affect the net receipts considerably. These calculated changes were not always in agreement with those predicted by experienced company officials.

As the authors point out, this suggests that when conditions are stable, even under complex conditions, experience will give an optimum or near-optimum program; but when conditions change rapidly, cut-and-try methods likely are to depart considerably from optimum solutions. Thus the main advantages of linear programming lie not necessarily in the fact that it provides better solutions, but more in the fact that it provides a complete routine procedure which can investigate changing conditions rapidly, and which can be handled by less skilled personnel.

Linear programming, however, is but one of the mathematical disciplines which may be brought to bear on an operational problem. Others are applied statistics, perhaps the most important of all, and the related queueing theory and sampling theory; game theory, differential and integral calculus, symbolic logic, and Monte Carlo methods. In fact, any available analytical method will be used as the need arises.

The predominant position of statistics is perhaps a reflection of the unpredictable elements in human nature: Statistics is concerned with establishing which conclusions can be drawn when significant quantities of the problem are partly unknown (and perhaps unknowable).

An example of this is queueing theory, which predicts the characteristics of a queue or waiting line formed at some gate or service point when units (or persons) arrive in some statistical manner and are served at the gate in a known fashion. This occurs in many everyday affairs: People waiting in a cafeteria, aircraft stacked to land, parts waiting to be serviced in an overhaul shop, patients waiting to see the doctor, etc. The theory predicts the average length of the line, probabilities for given numbers of persons in the line, and probabilities for having to wait given lengths of time.

This theory is particularly important when the system is operating near capacity, that is, when the rate of arrival of customers is nearly equal to the service rate.[3] Here, important information can be obtained as to the best way of improving service and reducing queue length.

Another analytical tool is game theory. It is developed from the common-sense idea of a game between two (or more) opponents. Each has open to him several courses of action or strategies on which he can decide. He cannot decide, and in many cases does not know, the action of his opponents. However, outcome of the game depends on the combined actions of all players. The processes whereby the most advantageous strategies for each player are found are developed by the game theory.

This concept of a game has seen considerable use in the military field. However, in business and industrial problems, game theory methods have not, as yet, been extensively employed.

Monte Carlo techniques constitute a short-cut method for simulation of real-life events. When a mathematical model has been established, its input data, representing actual events, may be known to have certain statistical characteristics. While they can be obtained by observations (for example by counting the number of people arriving in a store or at a queue in given time intervals), it may be far easier to generate them artifically. The processes whereby this is done are called Monte Carlo methods. They are especially important where analytical solutions are not available for the mathematical model, which, consequently, must be examined by inserting numerous sets of data describing the event in question.

A tool which, in a sense, has grown up with operations research is the high-speed automatic computer. While it is true that it, in itself, merely adds muscles, making calculations faster, it is equally true that many of the analytical techniques

would never have been used in practice without the aid of high-speed computing. Sheer bulk of calculations would make their use prohibitive. Thus, for example, the moderate size of the linear programming example was set by the fact that a high-speed computer was not available. Problems of the size of 100 equations in 300 variables have been machine-computed, as compared to 10 equations in 22 variables for the blending problem.

Conclusion. Many people will argue that a great deal of the concept described here is not operations research, but industrial engineering, business research, quality control engineering, or applied statistics. It is true that operations research borrows heavily from all these fields. However, the name, Operations Research, appears to be an excellent one for a much wider field than any of the other disciplines. The term operation includes many activities besides those of business and industry; and research implies a more extensive use of theory and verification of theory by experiment than does earlier terms.

So, its name is warranted and is a fortunate choice. But it is not essential for the work. Most important are the investigative policies, those of science, those of separating what is known from what is not known. Knowledge of this gives business and industry the best possible basis for decisions.

That an approach of this type should be successful could, perhaps, be predicted from the achievements of research in engineering and the physical sciences. That it is successful is being brought out by the problems to which it is being applied, as described in the numerous papers giving OR case histories.

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Fixing Field Prices of Gas Will Be Difficult

• Federal Power Commission will find it hard to apply public utility regulation to gas production, which does not have public utility characteristics.

• Natural gas producer is unlike a public utility, as his business is erratic, irregular, and unpredictable.

• FPC may adopt usual rate base method of fixing rates for public utilities. If so, it will have trouble determining gas producers' costs and reasonable return on their investments.

• There is danger of inadequate incentive for producing gas and an ultimate shortage of gas supply.

• Regulation of wellhead price is unnecessary, as public interest is protected by competition among thousands of gas producers.

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THE OIL AND GAS industry has been watching with great concern developments in the Phillips case before the Federal Power Commission. From it likely will come the pattern of price regulation which the FPC will apply to producers of gas moving in interstate commerce.

Actually the case is almost eight years old. The commission first instituted an investigation of the Phillips Petroleum Company by order issued Oct. 29, 1948. It was a test case to determine (1) whether Phillips was a natural gas company within the meaning of the Natural Gas Act and (2) whether, if subject to Commission jurisdiction, the company's rates or charges for natural gas were unjust, unreasonable, unduly discriminatory, or preferential.

On Aug. 22, 1951, the commission issued an opinion to the effect that the company was not subject to regulation as a "natural gas company" as meant by the act. The investiga-

tion, therefore, was terminated. Parties pressing the case challenged the commission's ruling and carried the matter to the U. S. Supreme Court. On June 7, 1954, the court reversed the commission's opinion, forcing the commission to reinstitute its investigation of the company's rates, which the FPC did on Nov. 22, 1954.

The commission's staff spent months gathering information from company records, while in the meantime proposals were initiated in Congress to exempt natural gas producers from regulation, or at least to modify regulation greatly. Legislative effort failed when the Harris Bill was vetoed, leaving the FPC with responsibility for regulation, however distasteful the commission might have regarded the job.

The commission has a difficult task on its hands—the duty of applying public utility regulation to a business whose characteristics are not those of a public utility.

The erratic, irregular, and unpredictable economic situation characterizing the business of a natural gas producer sets him apart from a public utility. If he must be regulated, the commission ought to consider the eccentricities of his industry, not only in fairness to the industry and those who have invested in it, but in fairness to distributors and to consumers of natural gas who surely would not elect to run the risk of a gas shortage sometime in the future. Total consumer investment in gas-using appliances aggregates a vast sum. Less than full-line deliverability obviously would work economic hardship upon users of natural gas, especially household consumers whose equipment is not readily convertible to the use of other fuels and who consequently would have to bear the higher prices inevitably resulting from reduced deliverability.

Since there is no predictable relationship between investment and deliverability of gas (capacity to serve) in the natural gas producing industry such as is found in true public utility industries, the commission must make what the Supreme Court has referred to as "pragmatic adjustments" in its rate determining function, because the "result, not the method" is what counts.

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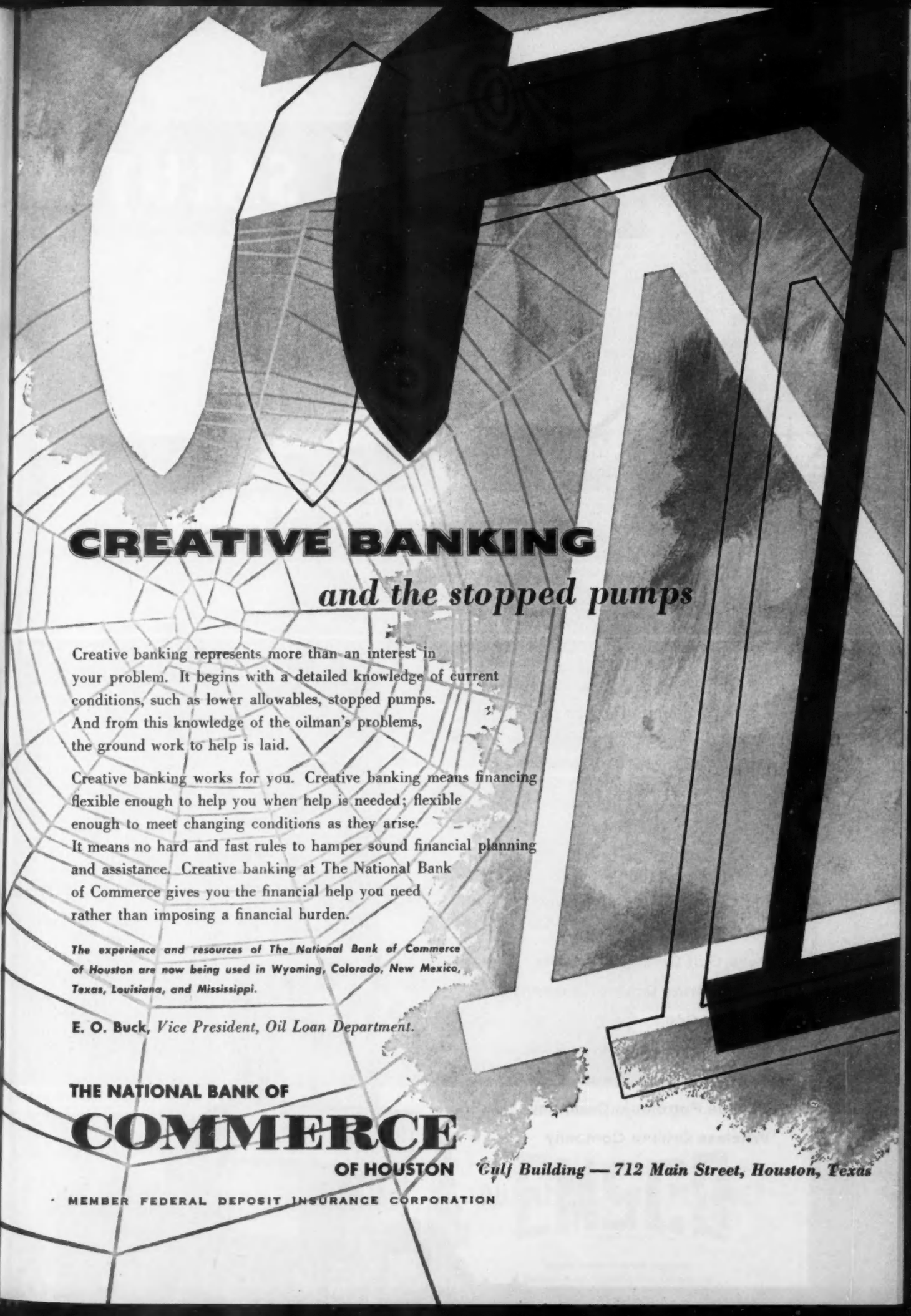
If such is not done, there is great risk that less gas will be sought and found. For some time the national ratio of gas reserves to growing annual requirements has been declining. Failure to seek and find adequate supplies can only lead to serious economic repercussions. Furthermore, since the commission's jurisdiction is limited to interstate business, there is always the possibility of increased diversion of gas to growing intrastate demand.

It is an indisputable fact that the cost of finding gas, like the cost of finding oil with which gas is closely associated in nature, has been climbing for a number of years. At least two reasons are paramount: (1) Oil and gas are simply getting harder to find in this country; (2) deeper drilling plus advances in labor, equipment, and materials prices have sent costs up sharply. In terms of unit costs, the facts are startlingly impressive: Last year (1955) each barrel of new oil reserves cost $1.15 to discover, compared with 77 cents average for 1950-1952 and with a mere 20 cents average in 1938-1940. When costs of finding oil in strictly new fields are examined, the figures are even more impressive: $2.59 per barrel last year compared with $1.79 in 1954 and with $1.24 in 1950. In the five-year period ending in 1954, the average annual gross addition of crude oil to reserves was 17.26 barrels for each foot of well drilled compared with 25.07 barrels for the five-year period ending in 1949, and with 23.81 and 28.55 barrels respectively for the periods 1940-1944 and 1935-1939.

Years ago producers explored primarily for oil. Gas at best was treated as a by-product for which there was a relatively small market. Sometimes gas was even regarded as a nuisance. Costs had to be supported solely from oil income. But today's growing natural gas market means that the search is now for both oil and gas.

As wells are drilled deeper the ratio of gas to oil found increases greatly. Unless the producer receives adequate prices for gas, he will hesitate to drill deep, exploratory wells. The incentive, in other words, must come from expected income from both oil and gas, if supplies are to continue to meet demand. Likewise, as proportionately more gas is found in the deeper reservoirs, gas must bear a greater share of exploration and development costs. Here, then, certainly is one justification for "pragmatic adjustment." The commission must not ignore greater finding costs in fixing current gas prices. And it is not sufficient to say that "the doors of the commission are open for increased allowances" sometime in the future.

It has long been the practice of companies to pay exploration and development costs out of current income; therefore, market prices and the amount spent in search of more reserves tended to be mutually reflected and interrelated. Adequate



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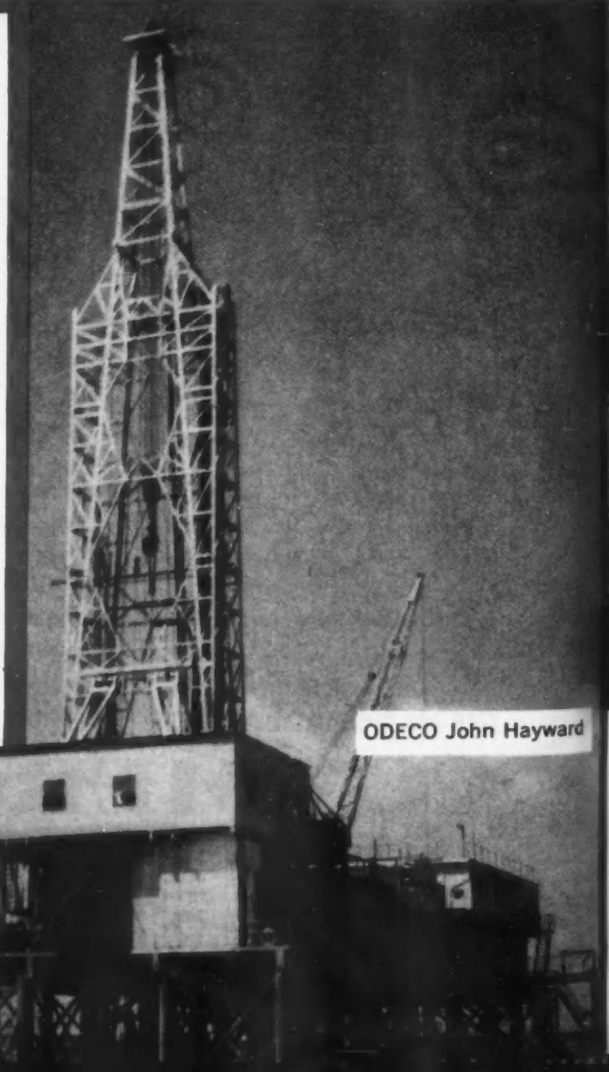

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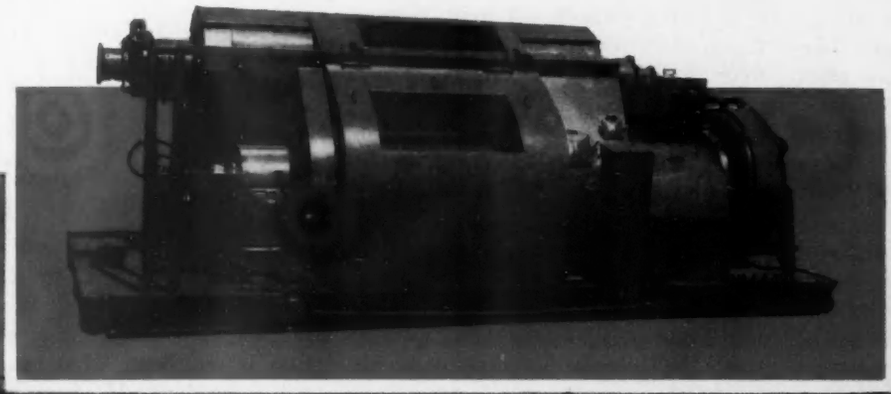

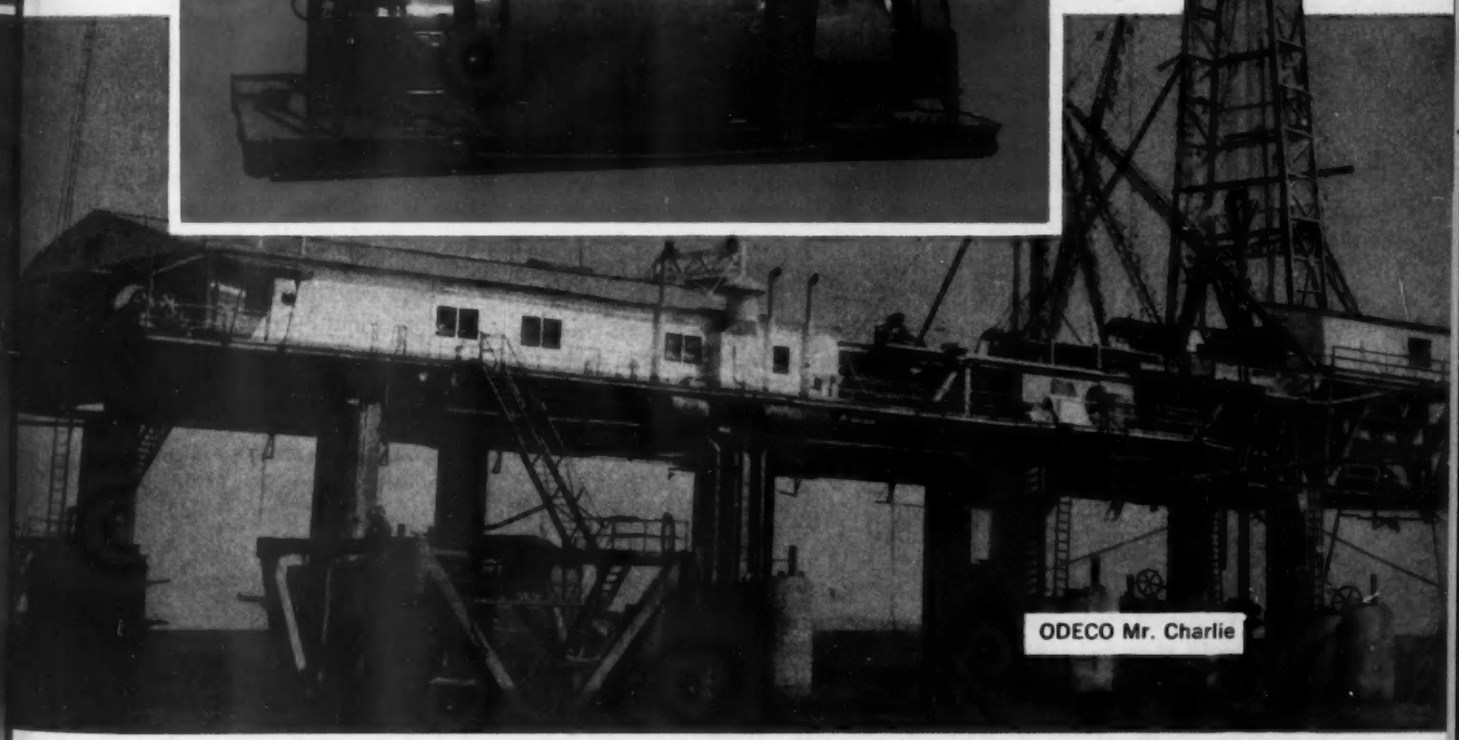

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allowance must be made currently as an incentive for exploration and for reserve acreage of proved and unproved gas land. True, such allowance is difficult to determine; but it is an essential factor, nevertheless, and one not present in conventional public utility rate-making.

Traditional public utility regulation technique has generally followed the rate-base method of fixing rates. Under this method the rate base is determined as the figure representing money prudently invested in properties and equipment (minus depreciation and depletion) and used in the company's business, including necessary working capital. The company is then allowed to earn enough to cover necessary operating expenses and a reasonable return or profit on the rate base.

If the commission follows this method (as it likely will), then the value used will reflect "costs," direct, imputed and allocated. In natural gas production (more especially in the case of an integrated company like Phillips) many important joint costs must be allocated between that part of the business over which the commission has jurisdiction and that over which it has no legal control. A few instances are worthy of mention: (1) Allocation of capital and overhead among petroleum, natural gas, chemicals, and all other production as well as selling activities; (2) allocation of exploration, proving and developing costs; and (3) allocation of operating expenses to casinghead gas produced jointly with oil and to various products of plants that process raw gas before delivery to pipe line companies.

Many natural gas producers have been in business for a long time and have accumulated large reserves of gas—a product, not a service; a product which is "tangible, possessible, and does have a market and a price in the field." A very real problem arises in how to value these reserves for rate-making purposes. As a part of the rate-base, should they be valued at historical cost?—or at replacement cost, reflecting today's high outlays for finding new reserves?—or at market value, which would really result in circular price-fixing? Whichever is used (and it probably will be historical costs), how much of the joint costs of petroleum and gas reserves should be allocated to each? These are problems not ordinarily found in typical public utility regulation.

After the rate-base is valued, the question of rate of return must be considered. How much shall the company be permitted to earn? Current doctrine, supported by the courts and followed by FPC and other utility regulating bodies, holds that the company shall be allowed to recover prudent operating expenses and earn a rate of return on the value of the property it employs (rate-base) "equal to that generally made . . . in other business undertakings which are attended by corresponding risks and uncertainties." In brief, this is the "cost of capital" principle under which a company is supposed to be able by efficient and economical management to maintain and support its credit and enable it to raise money for the discharge of its proper functions.

The above principle is rarely challenged, but there frequently is disagreement on the measurement of the return. Congress has merely said in the Natural Gas Act (paragraph 5) that the rates shall be "just and reasonable." The commission is left with the task of determining such rates. Certainly rates so low that investment is confiscated or so high that the consumer is exploited would not be "just and reasonable." Between these two points, however, there may be quite a span, and this is sometimes called the "zone of reasonableness." Within this zone, adversaries often wage bitter battles.

It is easy to concede the generalization that the rate-making process "involves the balancing of investor and consumer interests," but what are these interests? Financial integrity of the business is paramount to the investor—enough revenue for operating expenses and capital costs. The consumer or public interest is in adequate service at lowest possible rates. It would be contrary to consumer interest, however, if only the present and not the future were considered; or if service or deliverability were impaired or sacrificed to gain lower rates.

In any direction one may turn, as he views the FPC's task, the importance of an incentive factor persists. It is impossible to fix a just and reasonable price for natural gas without taking into account its effect upon future production of gas. The commission might allow something for incentive (a) in the rate base by including more than the historical costs of gas reserves; (b) in adequate allowance for exploration, new leases, and development as current expenses; (c) in the rate of return on invested capital; or (d) in some combination of these. One thing is certain: On the basis of historical costs, a producer's depreciation and depletion are not sufficient at today's costs to replace the gas produced.

At least two additional problems of major import confront the commission in regulating natural gas rates:

- What is to be done with long-term contracts (some having 25 or more years yet to run) made between pipe line companies and producers several years ago at prevailing low competitive rates (as low as 4 or 5 cents per Mcf) and contracts in recent years at much higher rates (15 cents and above)? These "arms-length" contracts made under competitive conditions reflect market prices as of contract dates. If the commission lowers the high-rate contracts, it probably will be obliged to raise the low-rate ones to maintain the company's financial integrity. This will not make distributors and consumers happy who contracted at low prices.

- Will the commission fix one rate for the entire gas industry?—or company-wide rates?—or different rates for different fields or areas? If one rate is set, from what cost standard will it be derived?—from costs of the most efficient or luckiest producer?—or from costs of the least efficient or the unluckiest?—or from some average of costs? If differential rates are set, will the Commission undertake to throw a monopoly cloak around each —as is the case with true public utilities?

Actually the natural gas producing industry is sufficiently competitive that the public interest has not required market regulation. There are literally thousands of natural gas producers, and despite the presence of large concerns (not less than 50 would fall in the large category) evidence of monopoly is exceedingly difficult to find. Many other industries are dominated by far fewer big companies than one finds in the natural gas business, yet Congress has not legislated them into public utilities. —**The End**

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How Tight Money Affects Oil Industry

• Money is generally tight in drilling and refining areas of Mid-Continent and Southwest.

• Refinery and petrochemical plant expansion may be hampered.

• Pipe line construction is especially affected, as long term loans involved are hard to get and entail high interest rates.

• It will be harder henceforth for newcomers to get into the oil business. Also, for one company to buy out another.

• Some oil companies are turning to sale of stock or convertible debentures instead of borrowing.

• Bankers say that worthwhile projects can be financed for reputable companies. They comment that oil companies are not curtailing expansion plans because of tight money.

By H. T. BRUNDAGE
WORLD OIL Staff

THE TIGHT money situation is being felt appreciably in the petroleum industry. It is getting more difficult to raise money for drilling and development of leases. It is getting harder to finance refinery, petrochemical plant, and pipe line construction.

Banks that usually finance the oil industry are pretty well "loaned up." They go slow in making new loans.

The bankers insist, however, that tight money is not causing curtailment of oil company expansion plans. They declare that any worthwhile project still can be financed, although at the higher interest rates that now prevail.

These are some of the effects that the current tight money situation is having on the oil industry. These findings were made by WORLD OIL upon questioning several prominent bankers in New York City familiar with the problems of oil industry finance.

Money to Remain Tight. The Federal Reserve Board recently increased the discount rate to three percent, the highest it has been in many years, and is stepping up sales of Treasury securities in order to tighten up the supply of money available for loans.

The purpose is to mitigate strong inflationary pressures that the national economy generates as it runs at virtually full capacity. The purpose of federal monetary policy is not to curb business expansion too much, but to keep it orderly and to prevent inflation. Just where the line should be held is a matter of opinion.

Though most bankers in the U. S. who have been surveyed on the question think that current Federal Reserve policy is wise, there is some feeling that the controls are too stringent. If loan capital gets so tight that the economy is being unduly restrained, the Federal Reserve Board might lower its interest rates to member banks and take other measures to provide a greater amount of available funds. But at the present time, such action is not in sight. It appears that the tight money situation will remain, and it may even become tighter, before it gets easier.

Oil Financing Harder. Kenneth E. Hill, vice president of The Chase Manhattan Bank, said that the current tight money situation is making refinery, petrochemical plant, and pipe line construction more difficult to finance. But he felt that any worthwhile construction can be financed at higher interest rates. "Oil companies are borrowing more money, and the trend is likely to continue upwards," he commented. Hill was asked if he had any idea how many banks engaged in oil business financing were "loaned up," i.e., so heavily committed that they hesitate to make any new loans at all. He said that *most* of them are in this situation. As to geographic distribution of the problem, Hill thinks that money is "probably tighter in the oil country" than in some other parts of the nation.

Several bank people contacted preferred that their names not be used, in view of policies of their respective institutions and the sensitivity of a number of the questions put before

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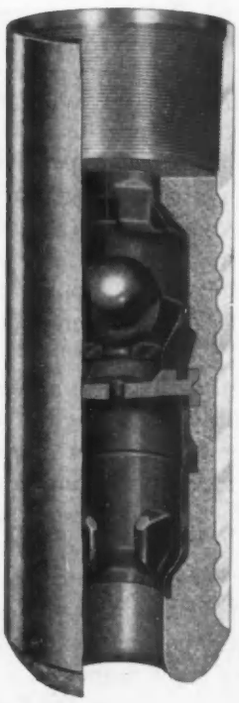
B—As the casing is lowered, pressure from below is exerted on the diaphragm and causes the hole to open up (see B) and a sufficient volume of fluid enters the casing to prevent a build-up of destructive pressure surges.

C—As the rate of lowering the casing is lessened (just prior to setting the joint in the slips) differential pressure from below decreases and permits the Flow Control Diaphragm to contract, thus causing the hole to return to its smallest diameter (C). The reduced volume of fluid entering the casing prevents overfill.



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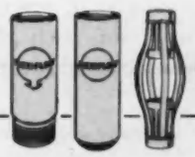

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them. A point made, of which perhaps few people are cognizant, is that the money shortage is not peculiar to the U. S. Interests on loans are even higher in Germany and England, for instance. While the U. S. has enjoyed a large post-war expansion, there has been a proportionately greater expansion in Western Europe, starting first with reconstruction. The demands for loan capital there have been so high that the pressure even affects U. S. bankers, particularly in New York and other Eastern financial centers. Much Eastern U. S. capital flows to the interior of the country. But some of it goes into foreign projects, too.

A recent survey published in *U. S. News and World Report* showed money to be generally very tight in cities close to vigorous drilling and/or refining activity, such as New Orleans, Dallas, Wichita, and Chicago. In at least two areas away from the oil country, Maine and South Carolina, the money situation was not tight. Many local factors are involved. But it appears that wherever vigorous construction of manufacturing plants is taking place, money is tight.

Pipe Lines Handicapped. The tightness of the supply of both money and of steel may hamper refinery and petrochemical plant expansion. Pipe line construction may be hurt the most, for the same reasons and also because of the current reluctance of most natural gas producers to commit their reserves to interstate transmission. Financing of pipe lines often entails longer terms than other oil business financing. The difference between, say, 5 percent and 6 percent is more important to pipe line financiers than to those financing projects with a shorter payout. In all cases, it is much easier to borrow on a short term than a long term basis. Bankers want the money back as soon as possible, so they can use it to satisfy other good loan prospects. They dislike having to commit money on any longer terms than necessary.

Not only are many banks "loaned up." One large insurance company is reported to be "loaned up" too, so greatly has the demand for loan capital outstripped usual sources of supply.

One result of the shortage of money for loans is that many oil companies are selling more equity capital, in the form of stocks and convertible debentures.

Loans "Rationed." The bankers contacted insisted that any worthwhile projects could be satisfactorily financed for reputable companies, large and small. Since it is generally agreed that the big oil companies are borrowing more money, the question arises whether this is making the supply even tighter for the industry as a whole. Though there may be a tendency in this direction, one bank representative pointed out that there is a legal limit to the amount of money a bank can lend to one applicant. This varies, depending on the reserves of the bank and other factors and does not exceed fifty million dollars for any bank in the country. It was further explained that there has been no such deal of this magnitude in which at least three big investment firms, typically two big banks and one insurance company, did not jointly participate in the financing. And this works on a smaller scale, too, so that in effect most, if not all banks "ration" their loans so as to satisfy as many of their reputable customers as possible. It is also very common for a bank representative to seek ways in which a loan applicant might be able to get along on less money for his project, in order that he can get the job done with a smaller drain on the bank's reserves.

Oil Men Question Bankers. An unusual effect of the tight money situation was reported. Some oil men who have customarily dealt with one bank are now beginning to fear that despite their excellent relationship through the years, when they need to borrow more money it simply won't be available because the only bank at which they have credit and standing is entirely loaned up. Large deposits have reportedly been transferred from one bank to another because some oil men don't want to put all their eggs in one basket. Furthermore, some of them have put their money in new banks only after being satisfied that the ratio of reserves to current loans was not such that needed capital would be unavailable. So there is a switch—prospective bank*ees* are asking bankers very pertinent questions about the bankers' business before deciding to put their money in a particular bank.

Drilling Continues. Generally the tightness of money is not noticeably affecting drilling activity. But the possible future effect on drilling is uncertain. There might be a slight tendency toward emphasis on field development drilling at the expense of wildcatting, because of the better assurance of profit in the case of small marginal companies. But this aspect is pretty nebulous too. Speculative projects will be more and more difficult to finance through bank loans as money gets tighter. This sort of thing has about the lowest priority from the bankers' viewpoint.

Oil operators desiring to finance an inventory buildup will find hard going, too. If an operator had a sudden opportunity to stock up on tubular goods, for instance, he should be prepared to do so on a cash basis.

It may be tougher now for newcomers to get into the oil business, or for that matter, any business, because of tight money.

It is also harder for a company buying out the assets of another to borrow money to do it. For one thing, bankers dislike to allow loans to accommodate a mere transfer of assets, when a good construction project might be left hung up as a result. However, the many long term oil payment deals that are accompanying many recent oil company mergers are not because of tight money. Other advantages, mainly of a tax nature, are involved, and would apply regardless of whether money were tight or not.

The danger that in view of the outlook for even tighter money in the near future, some companies might try to borrow more money immediately, before the situation worsens, was discounted by Hill of The Chase Manhattan. He also commented that he knew of no oil company that is revising its expansion plans downward because of tight money

—**The End**

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REPORT FROM THE OBSERVATORY

By **RAY L. DUDLEY,** Publisher, and **WARREN L. BAKER,** Editor

Outlook Shows Slight Improvement

Growth in gasoline stocks narrowed somewhat by reduced refinery operations during recent weeks. However, this trend must be continued throughout winter.

Slight improvement in the industry's market outlook took place in recent weeks. Substantially reduced refining operations resulted in some narrowing of the gulf between current and year-ago gasoline stocks.

However, the industry still has a long way to go before any substantial improvement can be achieved in the outlook. U. S. inventories, especially of gasoline, still are far too excessive. The situation calls for diligent regulation of refining operations to fit current needs.

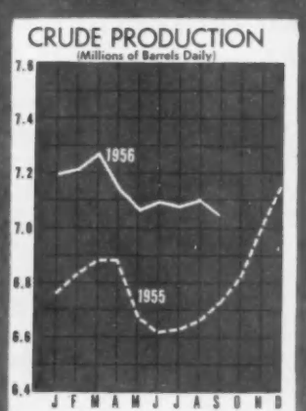
Crude supplies also are on the high side. Both domestic production and imports need to be kept in line with needs.

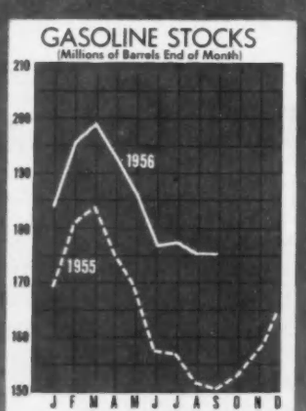
•

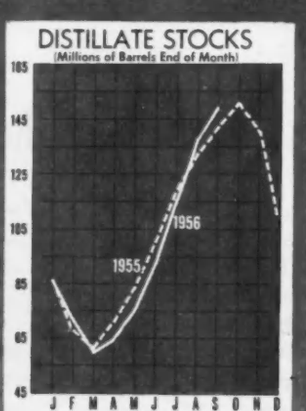
Refinery operations in the months ahead must continue to be held to the reduced volumes that existed during the first three weeks in October. In addition, sharp downward adjustments must be made in gasoline recovery per barrel processed. Only if it fully uses these two courses of action during the coming five winter months, can the industry hope to alleviate its critical surplus accumulation of gasoline supplies.

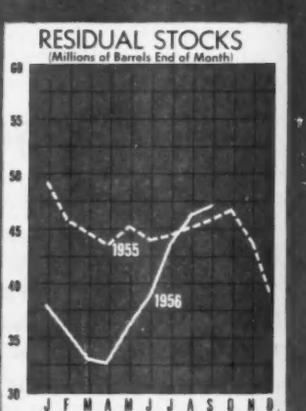
During the first three weeks of October, U. S. crude runs to refinery stills was nearly 500,000 per day less than the average throughput for September. This was a long overdue step. Beneficial results were immediately noticeable. A slight decline in gasoline stocks resulted in these inventories being but 21½ million barrels larger than year ago levels, although they had been 25 million barrels greater

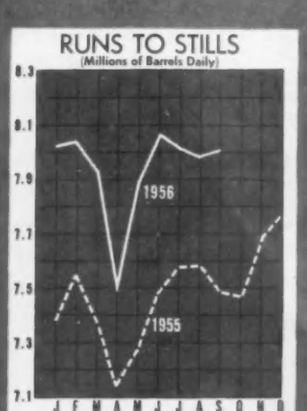
Petroleum Trends . . .

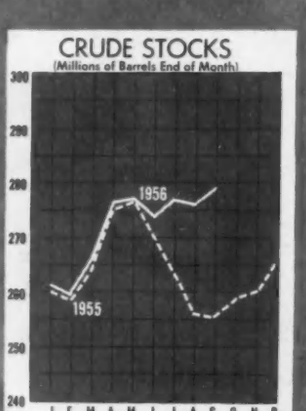


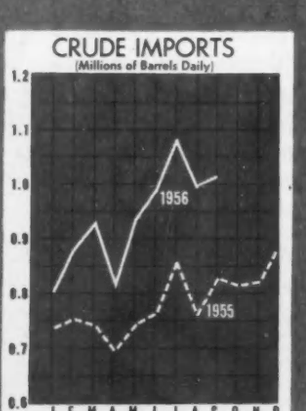


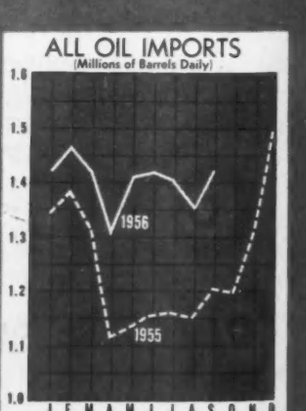












than the previous year just a month before.

If this trend is continued over a long enough period, the critical oversupply in gasoline can be relieved. Lower refinery runs will need to be accompanied by a downward adjustment in gasoline yields, and an upward adjustment in distillate fuel yields to provide enough heating oil for the coming winter.

Start of the heating season has brought better distillate prices. Meanwhile, gasoline prices have declined somewhat. This narrowing of the price spread between gasoline and distillate should give refiners an incentive for adjusting yields. This development engenders hopes that refiners will properly adjust yields to fit requirements dictated by the industry's present market requirements.

•

Crude oil supplies also need to be watched closely during the approaching winter months. Both domestic output and imports have been above desirable volumes. Supply must be held to current needs. This will be especially true if refiners successfully reduce crude runs to stills.

U. S. crude oil stocks totaled 279 million barrels on October 13. This was 5 million barrels higher than a month ago, and 24 million barrels above a year ago. Domestic production and imports should be held to levels that will prevent any further stock growth.

Much of the increase has occurred in Texas. Texas crude stocks were 4½ million barrels above a year ago, of which 3½ million represents West Texas crude.

•

The whole difficulty in which the industry now finds itself is the result of failing to hold supply to normal seasonal requirements. Demand has been good. It has averaged slightly over 9 million barrels per day during the first nine months of 1956, nearly 6 percent above the similar period of 1955. However, supply has been steadily above this level by more than 300,000 barrels daily.

As a result, inventories have piled up until they have reached critical levels. Consequently, supplies must now be held below current needs so as to reduce surplus stocks.

U. S. Crude Oil and Refined Product Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1955:											
January	6,761	7,379	260,156	3,639	169,562	1,740	86,692	1,235	49,457	739	1,348
February	6,835	7,549	258,630	3,655	181,643	1,847	68,513	1,239	46,042	751	1,379
March	6,886	7,374	264,430	3,543	183,972	1,703	62,457	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	1,534	70,139	1,110	43,838	697	1,123
May	6,677	7,281	276,948	3,605	168,751	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	1,628	100,652	1,080	44,398	764	1,159
July	6,632	7,580	264,601	3,824	157,079	1,575	119,169	1,091	44,894	860	1,161
August	6,665	7,580	256,427	3,858	151,912	1,621	133,675	1,090	45,480	756	1,155
September	6,731	7,483	256,269	3,784	150,194	1,621	143,248	1,061	46,267	829	1,218
October	6,831	7,465	267,346	3,827	153,103	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	1,680	141,808	1,214	44,071	823	1,322
December	7,155	7,762	265,610	3,916	165,433	1,765	111,333	1,286	39,174	884	1,502
1956:											
January	7,199	8,023	261,592	3,927	183,905	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	1,918	71,335	1,286	35,673	878	1,472
March	7,278	7,914	265,683	3,829	199,698	1,808	60,846	1,213	32,984	934	1,425
April	7,146	7,487	277,121	3,646	193,299	1,713	63,571	1,130	32,740	815	1,305
May	7,064	7,896	277,497	3,859	186,673	1,667	75,928	1,149	36,607	938	1,416
June	7,100	8,071	274,491	3,976	177,076	1,755	93,758	1,098	39,073	987	1,426
July	7,090	8,014	277,008	3,975	176,536	1,767	115,787	1,066	43,958	1,084	1,463
August	7,105	7,987	277,166	3,953	175,625	1,832	139,060	1,123	46,842	992	1,353
September	7,046	8,001	278,415	3,920	175,268	1,822	149,751	1,102	47,413	1,017	1,421
Week Ended:											
10-12-56	6,990	7,498	279,458	3,772	174,062	1,772	153,199	1,099	47,349	807	1,193
10-14-55	6,714	7,357	255,134	3,652	150,480	1,557	148,849	1,091	47,288	839	1,161

Source: Data for last two months from API; prior data from Bureau of Mines.

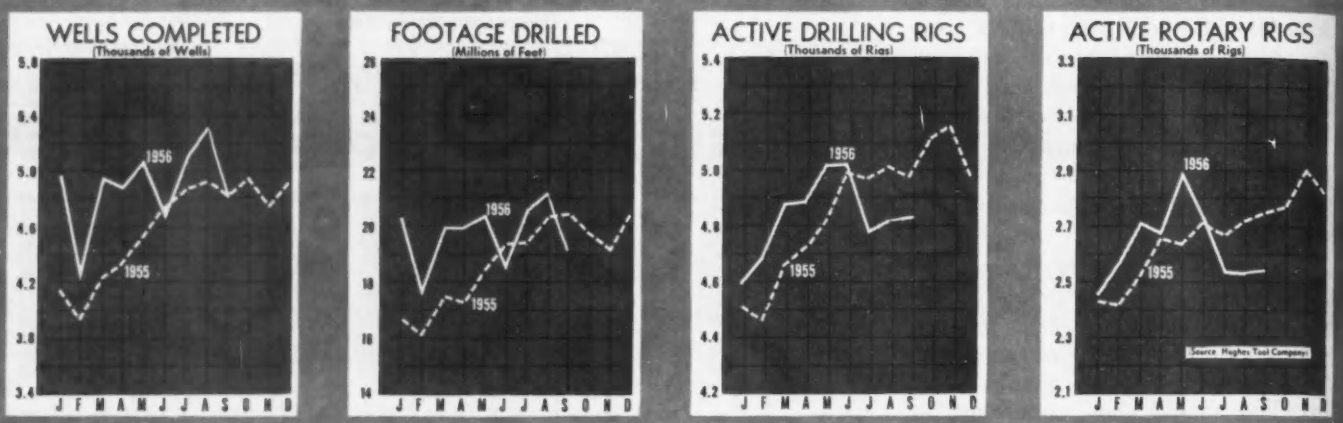
U. S. Crude Production

(THOUSANDS OF BARRELS)

STATE or DISTRICT	DAILY AVERAGE PRODUCTION				TOTAL PRODUCTION		
	Sept., 1956	Aug., 1956	Sept., 1955	% Diff. September 1956-1955	1956	1955	% Diff. 1956-1955
Alabama	9.2	7.6	3.9	+135.9	1,929	1,008	+ 91.4
Arkansas	79.6	77.9	80.5	— 1.1	21,530	21,424	+ 0.5
California	958.8	960.3	969.2	— 1.1	264,292	265,231	— 0.4
Colorado	160.0	158.7	151.6	+ 5.5	44,219	37,073	+ 19.3
Florida	1.3	1.3	1.3	.....	366	364	+ 0.5
Illinois	235.8	231.0	231.0	+ 2.1	62,095	60,753	+ 2.2
Indiana	31.4	31.0	28.4	+ 10.6	8,171	8,204	— 0.4
Kansas	338.5	342.4	332.7	+ 1.7	93,405	90,997	+ 2.6
Kentucky	46.8	47.5	43.4	+ 7.8	13,084	11,225	+ 16.6
Louisiana	788.7	788.9	750.3	+ 5.1	219,187	197,079	+ 11.2
North Louisiana	121.4	122.4	123.4	— 1.6	34,485	32,541	+ 6.0
South Louisiana	667.3	666.5	626.9	+ 6.4	184,702	164,538	+ 12.3
Michigan	28.2	28.3	30.8	— 8.5	8,158	8,519	— 4.2
Mississippi	113.4	112.5	109.7	+ 3.4	30,434	27,129	+ 12.2
Missouri	0.2	0.2	0.2	.....	42	50	— 16.0
Montana	64.0	64.1	39.0	+ 64.1	16,073	11,660	+ 37.8
Nebraska	38.5	38.2	27.6	+ 39.5	11,424	6,868	+ 66.3
Nevada	0.2	0.2	0.2	.....	54	49	+ 10.2
New Mexico	239.8	233.1	222.1	+ 8.0	65,037	60,639	+ 7.3
Southeast New Mexico	238.0	231.3	219.6	+ 8.4	64,157	59,873	+ 7.2
Northwest New Mexico	1.8	1.8	2.5	— 28.0	880	766	+ 14.9
New York	10.4	10.2	8.2	+ 26.8	2,232	2,211	+ 0.9
North Dakota	33.0	35.1	35.3	— 6.6	9,793	8,155	+ 20.1
Ohio	13.9	13.1	12.4	+ 12.1	3,531	3,183	+ 10.9
Oklahoma	580.4	578.5	547.6	+ 6.0	162,115	149,816	+ 8.2
Pennsylvania	20.1	20.2	24.4	— 17.6	5,998	6,359	— 5.7
South Dakota	0.1	0.1	0.1	.....	24	25	— 4.0
Tennessee	0.1	0.1	0.1	.....	13	13	.....
Texas	2,958.8	3,023.8	2,785.9	+ 6.2	830,963	784,312	+ 5.9
Dist. 1—South Central	56.4	56.4	50.0	+ 12.8	14,932	13,876	+ 7.6
Dist. 2—Middle Gulf	150.2	153.2	145.0	+ 3.6	42,917	40,923	+ 4.9
Dist. 3—Upper Gulf	441.2	457.9	427.6	+ 3.2	124,382	123,792	+ 0.5
Dist. 4—Lower Gulf-S.W.	240.2	244.4	236.4	+ 1.6	67,026	66,579	+ 0.7
Dist. 5—East Central	42.6	43.3	50.0	— 14.8	12,372	13,151	— 5.9
Dist. 6—Northeast	330.7	340.1	330.7	.....	94,217	94,092	+ 0.1
Dist. 7-B—North Central	159.0	158.6	145.8	+ 9.1	42,872	38,640	+ 11.0
Dist. 7-C—West Central	182.8	193.1	169.9	+ 7.6	50,856	50,273	+ 1.2
Dist. 8—West	1,041.5	1,060.2	904.0	+ 15.2	286,584	255,142	+ 12.3
Dist. 9—North	213.2	217.1	196.2	+ 8.7	57,895	54,068	+ 7.1
Dist. 10—Panhandle	100.8	100.1	90.2	+ 11.8	26,249	24,029	+ 9.2
Utah	5.5	6.6	6.3	— 12.7	1,443	1,579	— 8.6
Virginia	0.1	0.1	0.1	.....	8	9	— 11.1
West Virginia	6.1	6.0	6.2	— 1.6	1,649	1,761	— 6.4
Wyoming	283.1	288.4	282.4	+ 0.2	78,358	74,846	+ 4.7
TOTAL UNITED STATES	7,046.0	7,105.4	6,730.7	+ 4.7	1,955,627	1,840,541	+ 6.3

Source: Data for last two months from API; prior data from Bureau of Mines.

Drilling Activity . . .



September's Wells Show Drop

An effect of recent steel strike shows up in form of 10 percent cutback in wells completed.

By CECIL W. SMITH, WORLD OIL Staff

THE RATE at which wells were completed in the U. S. during September represented a considerable decline from the record activity of August. Normally, a slight drop occurs in September, principally because the month is a day shorter than August. But this year other factors entered the picture.

Shortage of tubular goods brought on by the recent steel strike has just begun to become evident in well completion statistics. By the end of July, the number of active drilling rigs in the U. S. had dropped substantially due to the thinning out of pipe supplies. During August a few rigs found their way back to the field, and a few more were added in September.

Despite the slackening in the number of drilling units, the number of wells being completed held high. During July and August, successive all-time peaks were set in wells completed. But the day-of-reckoning came in September.

The month saw a total of 4801 new wells completed. That was a drop of 533 wells from the all-time peak of 5334 recorded in August, and was 95 wells less than those credited to September of last year. This was the first month in 1956 that failed to top its counterpart of last year.

However, the year's wells still maintained a sizable lead over the 1955 record, despite the cutback.

Total new wells completed in the first nine months of this year amounted to 44,150. That represented an increase of 3347 new wells or 8.2 percent over the 40,803 drilled in the same period of 1955.

Wildcatting Decline. Wildcat drilling suffered slightly more than did over-all activity during September. The number of tests completed during the month represented a decline of 11.4 percent from the all-time high recorded in August, while the over-all drilling cutback amounted to 10 percent.

The month's wildcats numbered 1062, compared with August's 1198. Of these tests, 119 were productive in September for a score of 11.2 percent, and August's 156 discoveries amounted to a somewhat better 13 percent.

In nine months, wildcats drilled totaled 9419 to lead the 8398 drilled in the comparable period of 1955 by 12.2 percent. However, this lead had amounted to 13.4 percent a month earlier.

At the close of September, a total of 4828 drilling rigs was at work in the U. S. That was only a slight gain from the 4819 active a month before, but it was a continuance of the upward movement, at least, from the season's low of 4775 rigs at the end of July.

Summary of U. S. Wildcat Drilling

ITEM	Sept., 1956	Aug., 1956	NINE MONTHS January-September 1956	1955	Percent Diff.
New Field Discoveries:					
Oil	86	108	818	831	— 1.6
Distillate	10	18	86	94	— 8.5
Gas	23	30	176	170	+ 3.5
Total Discoveries	119	156	1,080	1,095	— 1.4
Dry Wildcats	943	1,042	8,339	7,303	+14.2
Total Wildcats	1,062	1,198	9,419	8,398	+12.2
Percent Productive	11.2	13.0	11.5	13.0	.....
Percent Dry	88.8	87.0	88.5	87.0	.....

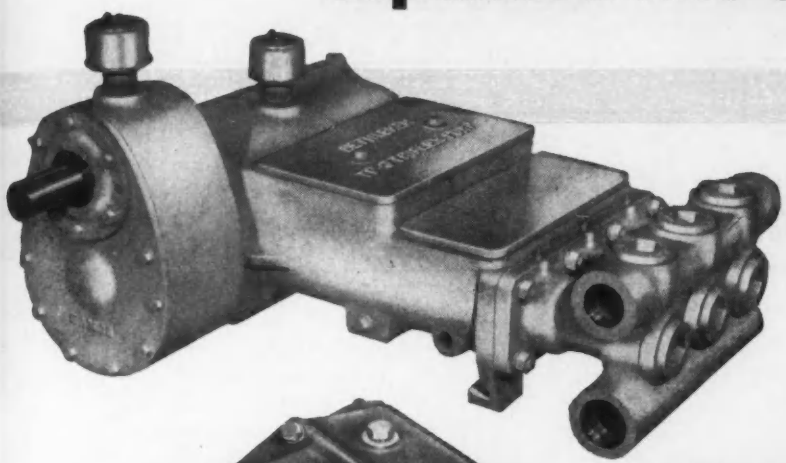
(See Page 104 for details)

Summary of U. S. Drilling Activity

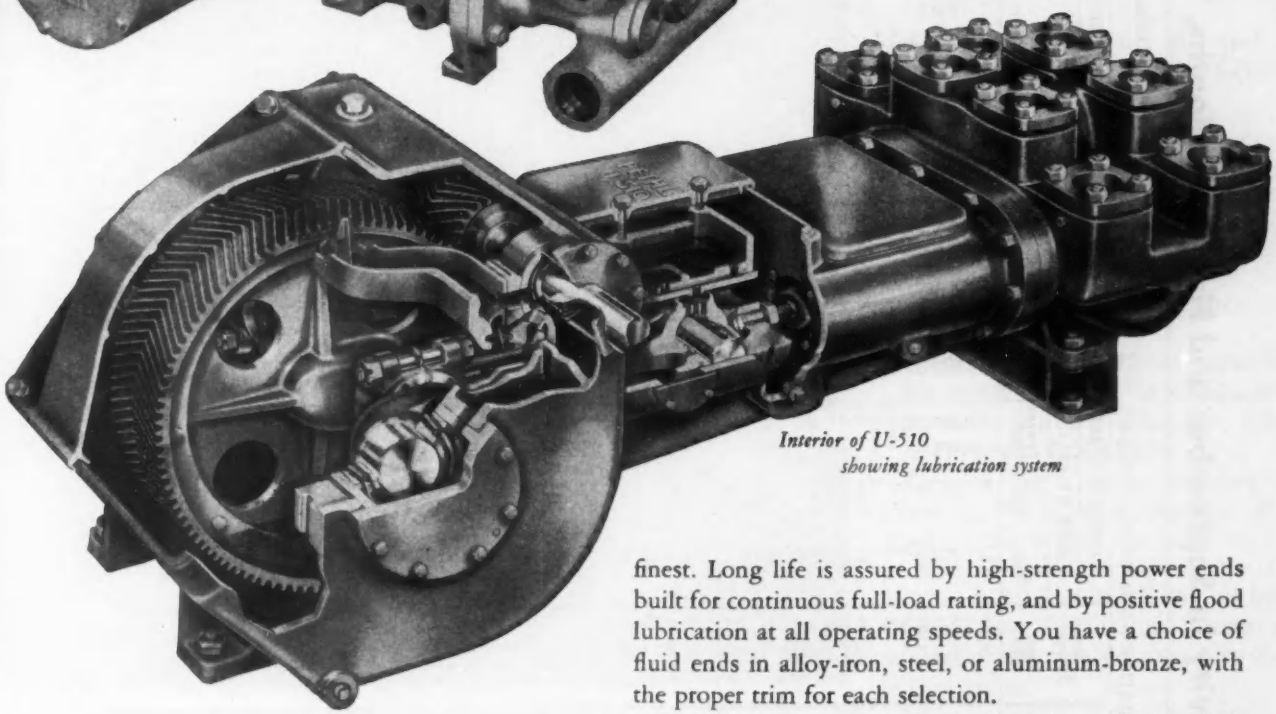
ITEM	Sept., 1956	Aug., 1956	NINE MONTHS January-September 1956	1955	Percent Diff.
New Wells Completed:					
Oil	2,428	2,779	23,442	22,570	+ 3.9
Distillate	52	74	437	585	—25.3
Gas	341	359	2,964	2,416	+22.7
Service	101	81	716	500	+43.2
Dry	1,879	2,051	16,591	14,732	+12.6
Total Wells	4,801	5,344	44,150	40,803	+ 8.2
Footage Drilled (Mln. of Feet)	19.0	21.3	178.7	166.8	+ 7.1

(See Page 104 for details)

Pick your "Handy Man" from this expanded line of power pumps



TP-3 Triplex Pump



Interior of U-510 showing lubrication system

Bethlehem now offers five distinct sizes of general-service pumps, so that it's even easier to pick just the right unit. We doubt that you've ever seen a line of pumps with so much versatility. Each is a "handy man"—a pump that can readily be adapted for several different kinds of work.

Does your job involve waterflooding? Salt-water disposal? Pumping crude oil in gathering systems or pipe-line service? Pumping mud or water for the drilling rig? If the answer is yes, there are Bethlehem units that will fit perfectly into your engineering plans.

You can bank completely on the quality of these pumps. Components are exhaustively tested. Materials are the finest. Long life is assured by high-strength power ends built for continuous full-load rating, and by positive flood lubrication at all operating speeds. You have a choice of fluid ends in alloy-iron, steel, or aluminum-bronze, with the proper trim for each selection.

Bethlehem pumps are so well engineered that their salvage value is always high. We feel certain that their many advanced features will interest you. If you will write or call, our people will gladly furnish complete information.

FIVE SIZES, DUPLEX AND TRIPLEX

Model	Type	Plunger Load, lb	Input Hp	Bore & Stroke, in.
U-33	Duplex	2400	14 @ 180 rpm	1¾ to 3 x 3
UA-46	Duplex	5000	40 @ 120 "	2½ to 4 x 6
U-510	Duplex	12000	100 @ 75 "	3 to 5½ x 10
TP-3	Triplex	3580	22.4 @ 250 "	1¾ to 2¼ x 3
TP-4	Triplex	5000	42 @ 250 "	2 to 4 x 4

BETHLEHEM SUPPLY COMPANY

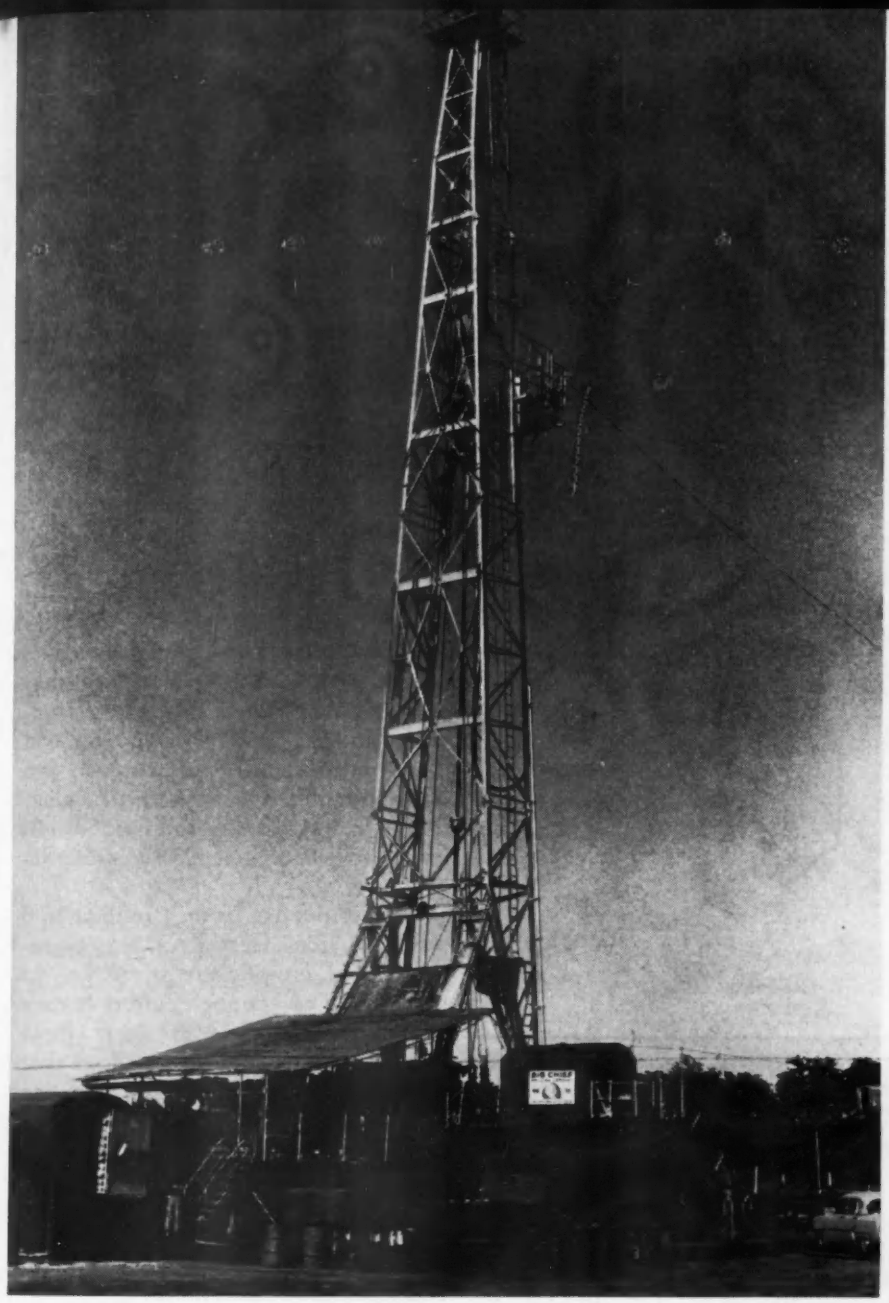
General Offices: 21 E. Second St., Tulsa, Okla.
West Coast Headquarters: Los Angeles, Calif.
Export Distributor: Bethlehem Steel Export Corporation
25 Broadway, New York, N. Y.

BETHLEHEM SUPPLY

U. S. Drilling Activity in September and First Nine Months, 1956-1955

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR SEPT., 1956: Oil	Dist.	Gas	Dry	Service Wells	TOTAL NEW WELLS: Sept. 1956	Aug. 1956	Sept. 1955	Total Footage: Sept. 1956	DETAILS FOR JANUARY-SEPTEMBER: NEW WELLS: 1956	1955	Percent Diff.	FOOTAGE: 1956	1955	WILDCAT DRILLING IN SEPTEMBER AND FIRST NINE MONTHS, 1956-1955: DETAILS FOR SEPTEMBER, 1956: Oil	Dist.	Gas	Dry	Total Wildcats	DETAILS FOR JANUARY-SEPTEMBER: Oil	Dist.	Gas	Dry	TOTAL WILDCATS: 1956	1955	DRILLING RIGS IN OPERATION: Sept. 30, 1956	Aug. 31, 1956	Sept. 30, 1955
Alabama	4	....	....	1	....	5	7	1	58,915	68	35	+ 94.3	571,480	145,878	....	....	....	1	1	....	....	1	19	20	34	11	14	6
Arizona	....	....	....	....	....	....	3	....	.....	7	4	+ 75.0	22,048	16,136	....	....	....	....	....	....	....	2	5	7	4	1	1	1
Arkansas	77	....	1	32	....	110	100	81	305,260	708	576	+ 22.9	2,157,335	1,898,893	1	....	....	13	14	10	....	3	99	112	113	61	67	58
California	123	....	6	49	....	178	200	191	831,275	1,623	1,776	— 8.6	7,609,962	8,826,264	2	....	2	29	33	8	....	7	199	214	255	196	194	248
Colorado	23	....	8	76	....	107	98	144	514,022	955	1,135	— 15.9	4,932,085	6,089,545	2	....	3	59	64	20	1	9	466	496	605	81	79	102
Florida	....	....	....	1	....	1	1	3	6,868	9	24	— 62.5	50,005	162,536	....	....	....	1	1	....	....	....	9	9	23	5	2	2
Georgia	....	....	....	....	....	....	....	1	.....	5	1	+400.0	22,008	4,130	....	....	....	....	....	....	....	....	5	5	1	1	1	2
Idaho	....	....	....	....	....	....	....	....	.....	1	3	— 66.7	4,528	11,337	....	....	....	....	....	....	....	....	1	1	3	2	2	....
Illinois	171	....	6	217	4	398	315	366	852,629	2,864	2,808	+ 2.0	6,623,810	6,784,469	1	....	....	96	97	15	....	1	733	749	534	264	279	294
Indiana	25	....	....	38	2	65	75	63	107,724	504	468	+ 7.7	877,887	717,179	....	....	....	13	13	2	....	....	123	125	150	107	90	105
Kansas	173	....	46	168	5	392	361	410	1,382,308	3,498	3,462	+ 1.0	12,336,062	13,272,134	12	....	5	85	102	126	....	28	782	936	852	510	509	456
Kentucky	71	....	18	77	1	167	198	150	270,385	1,408	1,205	+ 16.8	2,086,790	1,865,590	....	....	....	6	6	4	....	....	112	116	83	122	124	131
Louisiana	137	10	43	151	....	341	303	421	2,395,705	2,780	3,116	— 10.8	20,506,530	20,220,160	7	2	....	69	78	33	26	14	425	498	407	390	403	381
North Louisiana	72	3	20	77	....	172	147	202	611,469	1,202	1,572	— 23.5	4,371,311	4,784,646	3	....	....	31	34	8	1	2	163	174	144	71	79	90
South Louisiana	65	7	23	74	....	169	156	219	1,784,236	1,578	1,544	+ 2.2	16,135,219	15,435,514	4	2	....	38	44	25	25	12	262	324	263	319	324	291
* Gulf of Mexico	14	1	2	8	....	25	25	44	253,278	318	247	+ 28.7	2,980,739	2,307,082	2	....	....	3	5	4	5	4	40	53	39	47	54	51
Maryland	....	....	....	....	....	....	....	....	.....	4	....	....	30,716	.....	....	....	....	....	....	....	....	....	....	....	....	1	1	4
Michigan	12	....	3	17	....	32	33	55	95,049	336	392	— 14.3	959,925	1,160,626	....	....	....	14	14	4	....	1	118	123	154	65	69	84
Mississippi	9	....	....	33	....	42	38	40	291,755	328	340	— 3.5	2,353,016	2,538,783	....	....	....	24	24	7	2	....	139	148	134	37	37	43
Missouri	....	....	....	....	....	....	....	....	.....	21	24	— 12.5	23,811	13,095	....	....	....	....	....	....	....	....	15	15	17	3	1	3
Montana	29	....	....	30	1	60	69	42	292,041	374	255	+ 46.7	1,854,836	1,252,907	....	....	....	24	24	6	....	2	137	145	108	53	54	52
Nebraska	19	....	1	43	....	63	72	96	368,695	731	620	+ 17.9	4,230,275	3,601,407	3	....	1	21	25	34	....	1	316	351	271	26	28	47
Nevada	....	....	....	....	....	....	....	....	.....	5	6	— 16.7	28,571	44,828	....	....	....	....	....	....	....	....	3	3	4	4	3	1
New Mexico	61	....	48	34	....	143	196	173	673,781	1,486	1,268	+ 17.2	6,671,118	5,412,048	3	....	....	23	26	31	1	1	175	208	155	188	184	165
New York	31	....	....	....	19	50	55	34	70,000	346	266	+ 30.1	484,850	367,296	....	....	....	....	....	....	....	....	....	....	....	70	74	49
North Dakota	16	....	....	8	....	24	12	29	187,174	205	189	+ 8.5	1,543,621	1,316,191	....	....	....	6	6	9	....	....	56	65	51	26	26	29
Ohio	50	....	13	12	....	75	117	105	190,307	772	879	— 12.2	1,866,087	1,846,191	....	....	....	....	....	....	....	....	3	3	16	222	221	213
Oklahoma	327	6	18	208	11	570	669	661	1,975,564	6,025	5,710	+ 5.5	21,546,697	19,784,493	10	....	3	50	63	77	13	25	520	635	583	577	591	626
Oregon	....	....	....	....	....	....	....	....	.....	1	1	....	12,880	7,101	....	....	....	....	....	....	....	....	1	1	1	....	....	1
Pennsylvania	33	....	23	4	35	95	100	66	243,285	658	550	+ 19.6	1,794,112	1,039,323	....	....	....	....	....	....	....	....	....	....	3	175	169	125
South Dakota	....	....	....	2	....	2	7	2	1,244	16	9	+ 77.7	58,965	43,791	....	....	....	2	2	....	....	....	16	16	9	4	3	2
Texas	981	36	54	622	23	1,716	2,149	1,611	7,307,293	17,092	14,582	+ 22.8	72,430,997	64,058,408	40	8	8	379	435	420	41	75	3,628	4,164	3,592	1,294	1,274	1,426
Dist. 1: South Central	88	....	1	57	....	146	183	146	321,696	1,565	1,305	+ 19.9	4,078,570	3,439,827	1	....	1	47	49	19	1	5	387	412	311	39	42	58
Dist. 2: Middle Gulf	22	13	4	32	....	71	73	57	440,482	631	601	+ 5.0	3,904,431	3,567,071	2	1	1	23	27	11	6	5	191	213	225	40	47	41
Dist. 3: Upper Gulf	67	5	8	72	....	152	148	141	1,121,710	1,368	1,328	+ 3.0	9,268,234	8,495,855	2	1	2	49	54	19	9	6	341	375	344	148	137	147
* Gulf of Mexico	....	....	....	2	....	2	1	1	23,338	9	10	— 10.0	96,660	99,182	....	....	....	2	2	....	....	....	6	6	5	5	4	4
Dist. 4: Lower Gulf-S.W.	40	8	7	56	....	111	118	104	506,458	1,100	1,017	+ 8.2	5,750,568	5,386,112	1	3	3	41	48	17	13	17	332	379	347	72	64	78
* Gulf of Mexico	....	....	....	2	....	2	1	3	10,932	10	12	— 16.7	89,013	115,549	....	....	....	....	....	....	....	....	1	1	3	3	2	2
Dist. 5: East Central	5	....	....	15	....	20	20	17	72,691	189	197	— 4.1	630,106	763,771	....	....	....	14	14	....	....	....	104	104	109	11	10	21
Dist. 6: Northeast	46	4	6	34	....	90	76	73	514,657	689	536	+ 28.5	3,673,821	2,848,934	1	....	....	21	22	11	1	2	163	177	141	82	85	60
Dist. 7-B: North Central	136	....	3	105	2	246	277	218	863,556	2,308	2,309	— 0.1	8,188,863	7,365,702	12	....	1	61	74	134	....	12	752	898	817	120	118	172
Dist. 7-C: West Central	62	....	1	33	....	96	165	70	478,992	1,003	887	+ 13.1	4,561,064	4,878,536	5	....	....	24	29	37	....	2	219	258	240	122	120	119
Dist. 8: West	237	2	1	45	....	285	489	304	1,513,644	3,230	2,846	+ 13.5	16,634,046	15,558,450	10	....	....	24	34	77	3	2	318	400	396	327	300	392
Dist. 9: North	207	3	1	152	21	384	446	388	961,315	3,929	2,816	+ 39.5	11,468,151	9,128,707	2	2	....	62	66	77	2	8	750	837	616	230	262	246
Dist. 10: Panhandle	71	1	22	21	....	115	154	93	512,092	1,080	740	+ 45.9	4,273,143	2,625,443	4	1	....	13	18	18	6	16	71	111	46	103	89	92
Utah	5	....	2	1	....	8	13	16	44,907	105	79	+ 32.9	498,586	351,615	2	....	1	....	3	4	....	3	61	68	65	31	28	27
Washington	....	....	....	....	....	....	....	....	.....	1	....	....	7,493	.....	....	....	....	....	....	....	....	....	1	1	....	....	....	....
West Virginia	4	....	49	10	....	63	68	68	185,933	530	477	+ 11.1	1,420,674	1,249,390	....	....	....	....	....	....	....	....	....	....	20	190	190	191
Wyoming	47	....	2	45	....	94	75	67	368,489	684	543	+ 26.0	3,086,315	2,740,368	3	....	....	28	31	8	2	3	172	185	151	101	101	113
Total United States	2,428	52	341	1,879	101	4,801	5,334	4,896	19,020,608	44,150	40,803	+ 8.2	178,704,075	166,842,112	86	10	23	943	1,062	818	86	176	8,339	9,419	8,398	4,828	4,819	4,987
Total Western Canada	186	....	2	50	....	238	429	291	1,064,457	2,172	1,982	+ 9.5	10,224,375	8,504,302	....	....	....	....	....	....	....	....	....	....	....	226	252	225

* Gulf of Mexico wells are included in their respective district totals.



Rig drilling the British-American Harrison 2, discovery well of Knox-Simpson field, Grady County, Oklahoma.

Significant Lower Paleozoic Finds in Anadarko Basin

Recent Anadarko Basin discoveries boost Oklahoma reserve potential.

By JOSEPH A. KORNFELD
Geological Consultant
Tulsa

THE SEARCH for reserves in the deeper portions of the Anadarko Basin of western Oklahoma has resulted in a number of significant discoveries from the Ordovician and Pennsylvanian systems of the Lower Paleozoic rocks.

The writer has selected for discussion the following developments:

- Deep-seated major fault in heart of Anadarko Basin: Knox-Simpson field, Grady and Stephens counties.
- Faulted overthrust belt in southern part of Anadarko Basin: Apache Northwest field, Caddo County.
- Faulted anticline in heart of Anadarko Basin: West Cement field, Caddo County.
- North Shelf portion of Anadarko Basin: Oakdale field, Woods County.

These discoveries were selected from the standpoint of reserves, oil rate potential, and future development.

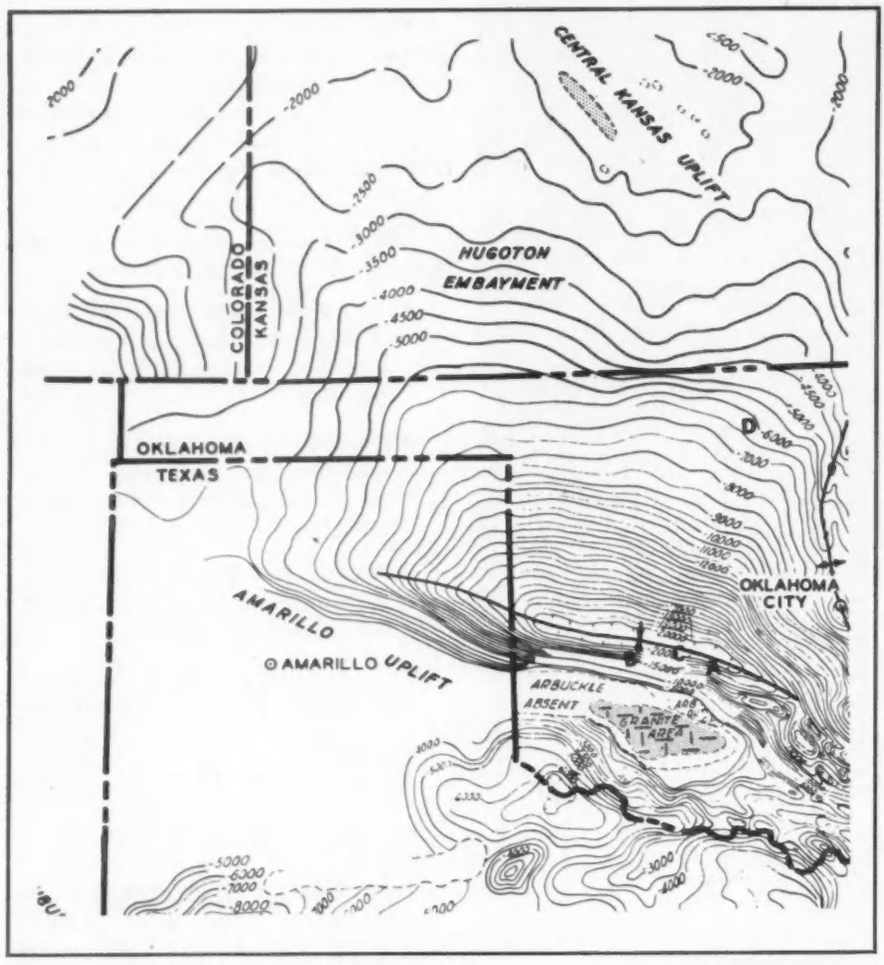
• ORDOVICIAN DEVELOPMENT ON FAULTED MAJOR ANTICLINE, KNOX FIELD, GRADY AND STEPHENS COUNTIES

One of the spectacular developments in the heart of the Anadarko Basin is the recent discovery of the prolific Simpson formation on the southwest flank of the Knox oil field, Grady County. This find marks the deepest production developed to date in Oklahoma.

Discovery well . . . British American Oil Producing Company, operator, The Ohio Oil Company, and associates, completed their spectacular Ordovician Simpson discovery well at Harrison 2, SE NW NE/4 Section 29-3n-5w, for an official commission potential of 175,000,000 cubic feet of gas and 26,075 barrels of distillate per day through open 2½-inch tubing. A gravity test of the distillate indicated 52.6 API.

Drilling Features

Intentional crooked hole . . . Principal feature of the drilling of the discovery well of the Knox-Simpson field is the intentional drilling of a crooked hole. Big Chief Drilling Company hit the target within 40



Subsurface structural contour map of the Anadarko basin and adjacent geologic features mapped on top of the eroded Ordovician Arbuckle surface. Initialed letters point to significant recent discoveries in the lower Paleozoic rocks at A—Knox-Simpson; B—Apache Northwest; C—West Cement, and D—Oakdale which are discussed in detail in this article. Geologic datum: mean sea level. (After John G. Bartram et al.)

feet of the desired hole bottom without employing whipstocks. Yet contractor still maintained contract deviation requirements.

Well location was chosen by contractor 1000 feet downdip to the southwest from the desired hole bottom in order to take advantage of natural drift. The horizontal displacement of the bottom of the hole was 961.87 feet at a bearing of N 47° 44′ E. Apparent total depth was 15,310 feet, but true vertical depth was 14,878.37 feet.

Deviation requirements . . . A deviation of 1° per 1000 feet of hole was allowed by British American officials. However, the safety of the hole was maintained through a contractual requirement that the course of the hole could not change more than 1½° over any 100-feet interval.

British American officials worded the drilling contract with Big Chief Drilling Company to provide for both increasing and decreasing rates of change as follows:

"Should the hole have an angle of deviation from vertical exceeding 1° per 1000 feet of depth attained after surface casing is set or a horizontal departure from a tangent course of more than 2.6 feet per 100 feet of drilled hole, contractor agrees, unless this requirement is specifically waived by company, to:

"(a) Reduce the excess deviation or reduce the rate of change of angle of deviation to the above limitations, or

"(b) Plug back to a point designated by company and redrill said hole at contractor's sole cost and expense.

"The foregoing limitation of rate of change shall not be applied in case of whipstocking approved by company."

The contract provided further that deviation surveys be run at regular intervals usually not exceeding 90 feet. British American furnished single-shot directional-survey instrument and monel drill collar.

Drilling procedure . . . After the 16-inch conductor was set and cemented at a depth of 520 feet, contractor cut a 9⅞-inch hole to about 9200 feet *before reaming.*

This procedure was employed because drilling experience by other operators in the Knox area in past years showed that key seats usually developed in drilling between depths of from 3500 to 4500 feet. However no key-seat difficulties were found in drilling Harrison 2 to 9200 feet.

Then the top portion of the hole was reamed out and a string of 10¾-inch surface casing set and cemented at 3337 feet. A 10¾-inch hole was cut to 14,940 feet in the Bromide Dense portion of the Simpson formation. At that depth, coring was commenced using a 7¾-inch diamond corehead. After 53 feet of core was cut, operators experienced a blowout followed by lost-circulation conditions with core-barrel remaining in the hole.

Gas estimated from 3 million to 6 million cubic feet per day was reported as crews were preparing to come out of the hole after cutting core from 14,947-14,997 feet. Crews mixed mud to kill the well so that core-barrel could be pulled. After the well was brought under control, the long string of 7-inch pipe was set and cemented at 14,931 feet.

Drilling and coring proceeded until an apparent depth of 15,310 was reached in the Third Bromide sandstone series of the Simpson.

Completion Summary

Liner run . . . A string of 587 feet of 5-inch liner was run to 15,251 feet only 59 feet off of bottom. Completion was made in the open-hole section which exposed only 59 feet of a 300-foot pay section in the Simpson formation.

Background of Play

Role of faulting in accumulation had long been known for the principal part of the Knox field lying to the east. A 5000-foot fault cuts the east side of the field. Prior to the British-American development, production in the Knox field was confined to the Permian and Pennsylvanian.

Back in 1946, The Ohio Oil Company started a deep play in this part of the Knox field and drilled a 10,169-foot test into the Springer

sands of the Pennsylvanian at its Harrison 1, C NE SW/4 Section 29-3n-5w, which location is one-half mile southwest of the new British-American discovery.

Then on March 11, 1954, Helmerich & Payne, Inc. Harrison 1, C NE SE/4 Section 31-3n-5w, one mile southwest of the current strike was abandoned at a depth of 13,010 feet in the Springer formation of the Pennsylvanian encountered at 12,555 feet. All Permian and Pennsylvanian formations carried salty mud or salt water on drill-stem test evaluations. This strategic deep test afforded important geological control.

Discovery of commercial Simpson reservoirs on nearby faulted anticlines encouraged British-American to drill a deep test on the southwest flank of Knox anticline. Complex faulting was encountered in the Pennsylvanian and pre-Pennsylvanian rocks and the Mississippian section was repeated four times. (See Formation Marker Summary).

Confirmation test . . . On June 14, 1956, British American and associates spudded their first confirmation test, at W. A. Reed 1, SW SW NE Section 20-3n-5w, Grady County; the surface location is situated approximately three-fourths of a mile north and slightly west of the Simpson discovery well.

Drilling practices employed in drilling Reed 1 are similar to those followed in the discovery well. Surface location was chosen at a point about 1000 feet southwest of the projected bottom-hole target for the purpose of allowing the bore-hole to drift updip to lessen drilling costs, a procedure employed in the drilling of the discovery well.

The following casing and cementing program has been employed in Reed 1:

Type	Size	Casing Seat	Cement
Surface	20″	120′	225 sax
Surface	13⅜″	3030′	2005 sax
Intermediate	9⅝″	13,235′	3000 sax

An intermediate string of pipe was not set in the discovery well. Operators set intermediate string in Reed 1 as added protection against possible blowout from high-pressure reservoirs in the pre-Woodford formation.

Structural correlation . . . Considerable attention is given to the correlation value of the Sycamore limestone as a geological marker in this area. The following shows correlation of the discovery and the confirmation test on this marker:

Formation Marker	Harrison 2	W. A. Reed 1
Top of Sycamore limestone	12,909′ (—11,750′)	13,140′ (—11,933′)

On last field report, Reed was waiting on cement to set after setting the intermediate string of casing in the Sycamore limestone.

Deep Simpson development on the Stephens county side of the structure commenced during September 1956 when British-American and associates announced location for their Krieger 1, C SW SW/4 Section 3-2n-5w. This strategic test is projected for a depth of 17,000 feet.

Spacing rules . . . The Corporation Commission of Oklahoma held a hearing on September 13 and 14 at Oklahoma City on the application of the British-American Oil Producing Company and The Ohio Oil Company for spacing and other rules for development of the deep Simpson formation in the Knox field. Hearing was then recessed until October 9, 1956.

Applicants sought the following:

(1) 640-acre spacing for natural gas and condensate development,

(2) A rule that there be no limitation put on the surface location, and

(3) That directional drilling be permitted.

Area sought to be spaced included:

GRADY COUNTY:

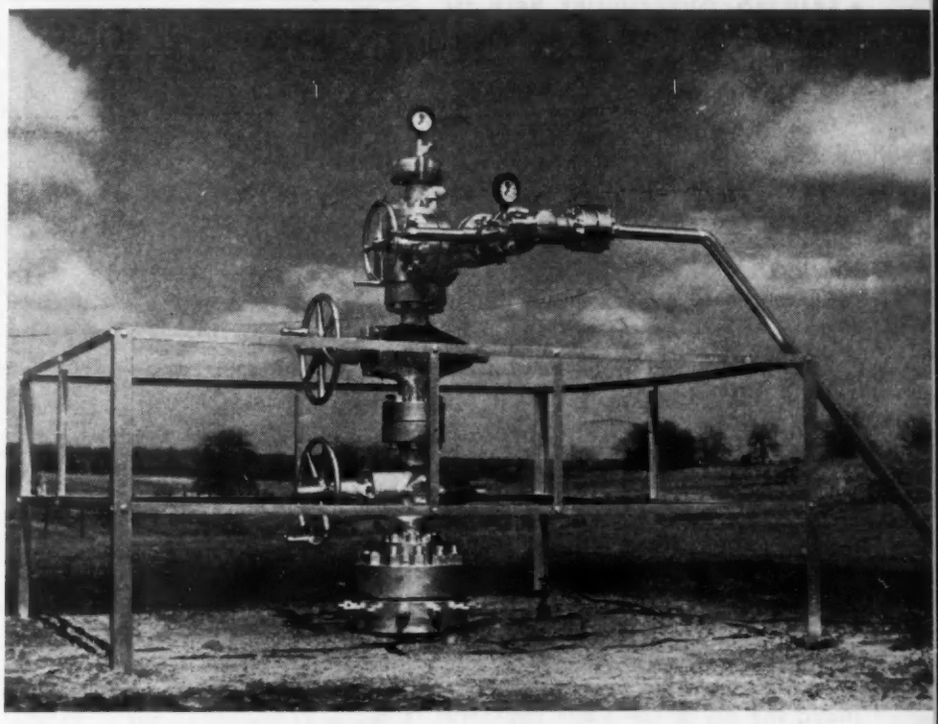
T. 4 N., R. 6 W: Sections 35 and 36.

T. 3 N., R. 6 W: Sections 1, 2, 3, 13, and 24.

T. 3 N., R. 5 W: Sections 6, 7, 8, 17, 18, 19, 20, 21, 28, 29, 30, 31, 32, 33, and 34.

STEPHENS COUNTY:

T. 2 N., R. 5 W: Sections 2, 3, 4, 5, 9, 10, 11, 14, 15, and 23.



Wellhead installation at the British-American Harrison 2, Knox-Simpson Field, Grady County, Oklahoma.

Formation Marker Summary, British American Oil Producing Company, Harrison 2, SE NW NE/4 Section 29-3n-5w, Third Bromide Gas-Distillate Discovery Well, Knox Oil Field, Grady County, Oklahoma.
(Elevation, 1159 feet k. b.)

FORMATION	Depth Feet	Datum Feet
First Woods sandstone	7,590	(—6,431)
Second Woods sandstone	7,650	(—6,491)
Mississippi	9,750	(—8,591)
Springer	10,018	(—8,859)
Mississippi	10,165	(—9,006)
Springer	10,465	(—9,306)
Mississippi	11,025	(—9,866)
Springer	11,315	(—10,156)
Mississippi	11,753	(—10,594)
Springer	11,805	(—10,646)
Springer sandstone	11,870	(—10,711)
Mississippian Caney shale	12,702	(—11,543)
Sycamore formation	12,909	(—11,750)
Woodford formation	13,132	(—11,973)
Hunton formation	13,365	(—12,206)
Sylvan shale	13,642	(—12,483)
Viola limestone	13,928	(—12,769)
Bromide dense	14,604	(—13,445)
First Bromide sandstone	14,715	(—13,356)
Second Bromide sandstone	14,910	(—13,751)
Third Bromide sandstone	15,113	(—13,954)
Total Depth	15,310	(—14,151)

• FAULTED OVERTHRUST BELT IN SOUTHWEST PORTION OF ANADARKO BASIN: APACHE NORTHWEST FIELD, CADDO COUNTY

One of the most significant 1956 oil discoveries in Oklahoma is Sinclair Oil & Gas Company et al's Susie 1, C NW SE/4 Section 1-6n-13w. It is the discovery well of the Apache Northwest field and is situated seven miles southeast of Carnegie in Caddo County.

Structure . . . Thrust faulting is known from deep wells drilled between the discovery well and the Wichita mountains.

Susie 1 lies along an arcuate belt of thrust-folding and faulting lying roughly parallel to the Wichita mountains.

During 1939-1940, Sinclair drilled German 1, SW NW NW/4 Section 1-6n-13w, only 3600 feet northwest of the present discovery. German 1 found the top of the Viola limestone 440 feet lower than in the Susie 1. German 1 was abandoned at 11,206 feet.

During 1945, Sinclair drilled Hall 1, NW NW SE/4 Section 36-7n-13w, one mile north of the Susie test; Hall 1 was abandoned at a total depth of 6110 feet in the Mississippian rocks and did not reach the Ordovician beds.

Two miles northwest of the new discovery, Shell Oil Company drilled a wildcat in the NW NW SW/4 Section 34-7n-13w. However, after logging Viola limestone 365 feet higher than in the discovery well, the Shell wildcat was abandoned at 10,365 feet.

Completion record . . . Operator set 7-inch oil string one foot off bottom at 9620 feet. Completion perforations were made from the following zones:

First Bromide series: 8711-8749 feet and 8763-8796 feet.

Second Bromide series: 8841-8853 feet and from 8869-8902 feet.

Fracture treatment was conducted through the above sets of perforations. Initial completion gauge was 533 barrels of oil in 18 hours produced through an $^{18}/_{64}$-inch choke. Produced gravity was 37.5 API. Initial produced gas-oil ratio was 855 cubic feet per barrel of oil.

Earlier the discovery failed to recover load oil from casing perforations conducted from 9402-9452 feet and from 9583-9608 feet in the McLish series of the Ordovician system.

Corporation Commission of Oklahoma granted the discovery well an allowable of 150 barrels of oil per day for a period of 44 days.

Spacing application . . . Sinclair Oil and Gas Company has applied to the commission for establishment of 40-acre spacing for the Bromide and McLish zones underlying the following areas: Township 6 North, Range 12 West: sections 6 and 7; Township 6 North, Range 13 West: sections 1, 2, 11 and 12; Township 7 North, Range 12 West: section 31, and Township 7 North, Range 13 West: sections 35 and 36.

Lease ownership . . . Discovery well was drilled on a 638-acre unit operated by Sinclair Oil and Gas Company. Distribution of ownership is as follows:

Operator	Percent
Sinclair Oil & Gas Company	44
Cities Service Oil Company	51
Oklahoma Natural Gas Company	3
Stanolind Oil & Gas Company	2

Sinclair also owns 2120 net acres of closein leaseholds situated outside of the drilling unit on which is situated the discovery well.

Arrow Drilling Company of Tulsa was contractor on the discovery.

• FAULTED ANTICLINE IN HEART OF ANADARKO BASIN: WEST CEMENT FIELD, CADDO COUNTY

One of the more significant field developments in the heart of the Anadarko Basin is the new West Cement field discovered on May 31, 1956. Five commercial oil and gas reservoirs of Pennsylvanian age have been proven productive by either drill-stem tests or completion tests from three wells drilled in the area by Amerada Petroleum Corporation. The new field lies one and one-half miles west and slightly north of the West Cement field proper.

Discovery of the West Cement field came after two deep dry holes were drilled in the vicinity of the discovery. Combined total footage of the two dry holes was 15,345 feet.

First test . . . The pioneer exploratory hole drilled in the vicinity of the West Cement structure was drilled 13 years ago. Amerada Petroleum Corporation's first test on this structure was its A. M. Monroe No. 1 in NW SW NE/4 Section 30-6n-10w. It was plugged and abandoned on June 1, 1943 after being drilled to a total depth of 8320 feet in the Pennsylvanian rocks.

Second test . . . The second test well in the West Cement structure was completed as a dry hole on May 31, 1956 at Amerada Petroleum Corporation's Walter S. Young 1, SE SE SW/4 Section 19-6n-10w. It failed to prove a commercial producer after being drilled to a total depth of 7023 feet in the Deese series of the Pennsylvanian system. Originally, it logged the top of the Pontotoc formation of the Wichita-Albany series of basal Permian age at 3602 feet. (—2203 feet).

This well found a showing in a Pennsylvanian sand section at 5348 feet. At a depth of 5377 feet, drill-

About the Author

JOSEPH A. KORNFELD has had wide experience in the petroleum industry field. A consulting geologist-reservoir engineer in Tulsa, he received his undergraduate and graduate degrees in geology from Texas Christian University and did post-graduate work in reservoir engineering at The University of Texas. He has been a reservoir engineer with Sohio Petroleum Company and The Texas Company and an engineering editor of The Oil and Gas Journal. Since March, 1954, he has been a consultant on natural gas and crude oil reserve appraisals, reserve studies, feasibility reports on natural gas and crude oil gathering systems. He is the author of more than 100 professional articles on petroleum geology, geophysics, secondary recovery and reservoir engineering on the Gulf Coast, Rocky Mountain, Mid-Continent and Illinois basin provinces.

stem test was run with packer set at 5351 feet. Testing tool was left open for two hours. Gas rose to surface in 50 minutes. Recovery in drill pipe was 375 feet of oil and 215 feet of heavily oil-cut mud, estimated 50 percent oil. A string of 5½-inch pipe was set and cemented at 5450 feet; this was perforated with 72 shots from 5352-5370 feet, acidized and fractured but with no success. Perforations were squeezed off and the zone reperforated at the same levels, acidized, refractured, diesel-squeezed with no commercial results and the hole was abandoned.

Field discovery . . . Encouraged by the high structural position and oil showing logged in Young 1, Amerada moved one-fourth mile due north of this well and drilled Young 2 at SE NE SW/4 Section 19-6n-10w. Young 2 found the top of the Pontotoc series at 3600 feet (—2221 feet) or only 18 feet structurally lower than in Young 1. However, Young 2 found the Pennsylvanian rocks progressively lower structurally than Young 1. Gregory limestone was found 350 feet lower and Griffin sandstone came in 361 feet lower in Young 2 than did the same formations in Young 1.

Young 2 was drilled to a total depth of 8575 feet (—7196 feet). It was completed on May 31, 1956 as a dual completion from the Wade and Marchand sandstones of Pennsylvanian age as follows:

Casing Seat: 5½-in. set at 8400 feet (—7021 feet) **Top of Wade sandstone** . . 7050 feet (—5671 feet). Perforations from 7057-7130 feet; calculated open-flow potential 21 million cubic feet of gas per day. **Top of Marchand sandstone** . . 8170 feet (—6791 feet). Perforations 8176-8244 feet; flowed 8.9 million cubic feet of gas per day.

Fleet Drilling Company of Ada, Okla., was the drilling contractor on the discovery well.

Medrano sandstone discovery . . . The second successful completion on the West Cement structure was made by Amerada on Sept. 6, 1956 at its R. E. Gish 1, NW SE NW/4 Section 19-6n-10w, extending the field one-half mile to the north and west. Hoxbar structural markers logged in Gish 1 compared 302 feet lower on the Upper Gregory limestone and 354 feet lower on the Griffin sandstone than in Young 2, the discovery well. Gish 1 was drilled to a total depth of 9884 feet (—8527 feet).

Medrano zone was found at 7870 feet (—6513 feet). Medrano sands were proven productive through casing perforations from 8140-8170 feet and from 8082-8129 feet. It flowed 423 barrels of 32.5 gravity oil in 16 hours through an 18/64-inch choke. Calculated flow rate was 635 barrels of oil per day. Shut-in tubing pressure was 650 psig.

None of the Medrano sandstones were present in the field discovery well.

Rowe sand discovery . . . The fourth reservoir to be indicated productive at West Cement was logged in Amerada's J. W. Leazenby 1 NW SE SE/4 Section 19-6n-10w, from the Rowe sandstone of Hoxbar age, the shallowest pay found to date in this field. Drill-stem test run at 5760 feet with packer set at 5692 feet flowed 6.6 million cubic feet of gas per day and some distillate from the Rowe sandstone. Testing tool was open for only 33 minutes; gas rose to surface in two minutes.

Yule sandstone discovery . . . The fifth reservoir proved for production at West Cement is the Yule sandstone of Hoxbar age found also in J. W. Leazenby 1. On a drill-stem test run at 6533 feet with packer set at 6510 feet, oil flowed at a rate estimated at 60 barrels per hour. Recovery in drill pipe was 4500 feet of pipe line oil. It was still drilling at the time of this report.

Summary of Formation Discoveries in West Cement Field, Caddo County, Oklahoma

System	Series	Formation	Depth	Pay Character
Pennsylvanian:	Hoxbar	Rowe	5,692‡	Gas-distillate
	Hoxbar	Yule	6,510‡	Oil
	Hoxbar	Wade	7,056*	Gas
	Deese	Medrano	8,082†	Oil
	Medrano		8,140†	Oil
	Deese	Marchand	8,176*	Gas

LEGEND:
* Productive in Amerada Petroleum Corporation's Walter S. Young 2, SE NE SW/4 Section 19-6n-10w, completed May 31, 1956.
† Productive in Amerada Petroleum Corporation's R. E. Gish No. 1, NW SE NW/4 Section 19-6n-10w, completed September 6, 1956.
‡ Drill-stem tested in Amerada Petroleum Corporation's J. W. Leazenby No. 1, NW SE SE/4 Section 19-6n-10w, drilling operation

• NORTH SHELF PORTION OF ANADARKO BASIN: OAKDALE FIELD, WOODS COUNTY

The Oakdale oil and gas field, situated 18 miles east and south of Waynoka in southeastern Woods County, Oklahoma, is illustrative of potentialities found in the Lower Paleozoic rocks lying on the north shelf portion of the Anadarko Basin.

While the potentialities of this field have not been completely evaluated, certain features are significant:

1. Significant crude oil and gas-distillate production have been found in the Simpson sandstones of Ordovician age at moderate drilling depths (7450 feet).
2. A series of gas-distillate reservoirs have been discovered from the Pennsylvanian system on the north limb of the Anadarko Basin.
3. Commercial gas-distillate production has been tested from two wells in the Hunton limestone marking the first commercial production to be found from this reservoir on the north limb of the basin.

Since the field discovery in November, 1955, production has been established from the following formations:

System	Formation	Average Pay Depth	Character
Pennsylvanian:	Layton sandstone	5441 feet	gas
	Cherokee sandstone	6108 feet	gas
Silurian-Devonian:	Hunton limestone	7126 feet	gas-distillate
Ordovician:	Simpson sandstone	7450 feet	gas-distillate, oil

Although only 240 attributable acres have been developed, no dry holes have been drilled in the field proper.

Discovery well . . . Oakdale field was discovered on Nov. 17, 1955 by Amerada Petroleum Corporation from the Simpson sandstone of Ordovician age. Discovery well was its W. H.

Correlation of Pennsylvanian Hoxbar Geologic Markers in West Cement Field, Caddo County, Oklahoma

FORMATION	W. S. Young 1 SE SE SW/4 Sec. 19 Elevation 1399 Feet	W. S. Young 2 SE NE SW/4 Sec. 19 Elevation 1379 Feet	R. E. Gish 1 NW SE NW/4 Sec. 19 Elevation 1357 Feet
Top U. Gregory ls.	3251	3601	3903
Top L. Gregory ls.	3514	3869	4213
Top Griffin sd. . . .	3717	4078	4432

Farris 1, C SW NW/4 Section 21-24n-13w, which was originally carried to a total depth of 8129 feet in Arbuckle dolomite encountered at 7702 feet.

Casing program . . . The following casing program was employed in drilling this deep test:

Type	Casing Size	Casing Seat
Surface	13 inch	292 feet
Protection	8 inch	2650 feet
Oil String	5½ inch	7610 feet

Spacing pattern utilized has been 1 well to each 40 acres and wells are located in the center of each 40-acre tract.

Simpson Reservoir

The field discovery, W. H. Farris 1, C SW NW/4 Section 21-24n-13w, also marked the discovery well for the Simpson sandstone reservoir. This well was plugged back from 8129 feet to 7474 feet where a plug was set and gun-perforator run.

Farris 1 was completed on Nov. 17, 1955 for an initial production of 285 barrels of oil per day through a ¼-inch choke. Accompanying gas volume was 1,171,000 cubic feet of gas per day. Completion perforations were made from 7446-7452 feet. The well was treated with 250 gallons of mud acid, then fractured. Load oil was returned and 101 barrels of new oil were produced in seven hours through a ¼-inch choke.

Subsequently, the south and west offsets to the discovery found salt water in the Simpson sands but were completed as commercial wells in shallower reservoirs.

However, Simpson sand development received impetus in this field with completion of a one-fourth mile east extension to the discovery at Amerada's John N. Hansen, C SE NW/4 Section 21-24n-13w. This well entered a gas cap in the Simpson.

Hansen 1 was completed on March 22, 1956 through completion perforations from 7450-7455 feet with 20 shots. Initial production was 113 barrels of distillate per day accompanied by 1,960,000 cubic feet of gas per day through a ¼-inch tubing choke.

Third successful completion for the Simpson sandstone reservoir was made one-fourth mile east of the Hansen gas-distillate well and one-half mile east of discovery well of the Simpson reservoir. Amerada's Rachel E. Copenhaver 1, C SW NE/4 Section 21-24n-1w, was completed on Sept. 6, 1956 for an initial potential of 128 barrels of oil per day with 101,000 cubic feet per day through a ¼-inch choke. Completion was made through casing perforations from 7447-7454 feet with 28 shots. Structurally, it is the highest well of the six wells drilled in this field to date.

Hunton Limestone Reservoir

Existence of commercial gas-distillate reserves in the Hunton limestone of Siluro-Devonian age at Oakdale is indicated from drill-stem tests conducted at two wells situated one-half mile apart along strike.

Chimneyhill limestone member of the Hunton formation was first proven gas productive in the field discovery's, Amerada's W. H. Farris 1, C SW NW/4 Section 21-24n-13w. Top of Hunton was called at 7105 feet (—5691 feet). On a drill-stem test run at 7236 feet with packer set at 7180 feet, Farris 1 gaged 1,117,000 cubic feet of gas in 11 minutes and 2,057,000 cubic feet of gas in 45 minutes. Recovery in drill pipe was 105 feet of mud and heavy distillate-cut mud.

The second field well to indicate commercial gas production from the Chimneyhill limestone was Amerada's Rachel E. Copenhaver, C SW NE/4 Section 21-24n-13w, which tested the Chimneyhill limestone late in July, 1956. Top of Hunton was called from samples at 7090 feet (—5678 feet), or 13 feet structurally higher than in the field discovery well.

Drill-stem test was run at 7140 feet with packer set at 7126 feet. Testing tool was allowed to remain open for 16 minutes. Gas was visible at the surface in only two minutes after testing tool was opened.

Maximum gas volume gaged was 9,980,000 cubic feet per day. Flowing pressures ranged from 633 to 1447 psig. Shut-in bottom-hole pressure was 3101 psig. Recovery in drill pipe was five feet of clean distillate.

Gas column . . . A gas column of at least 67 feet is indicated from reservoir studies with reservoir limits not yet determined to the north, northeast and east side of the reservoir.

Productive limits of the Chimneyhill limestone member of the Hunton gas-distillate reservoir were determined from drill-stem tests conducted at two wells situated on the southwest flank of the field:

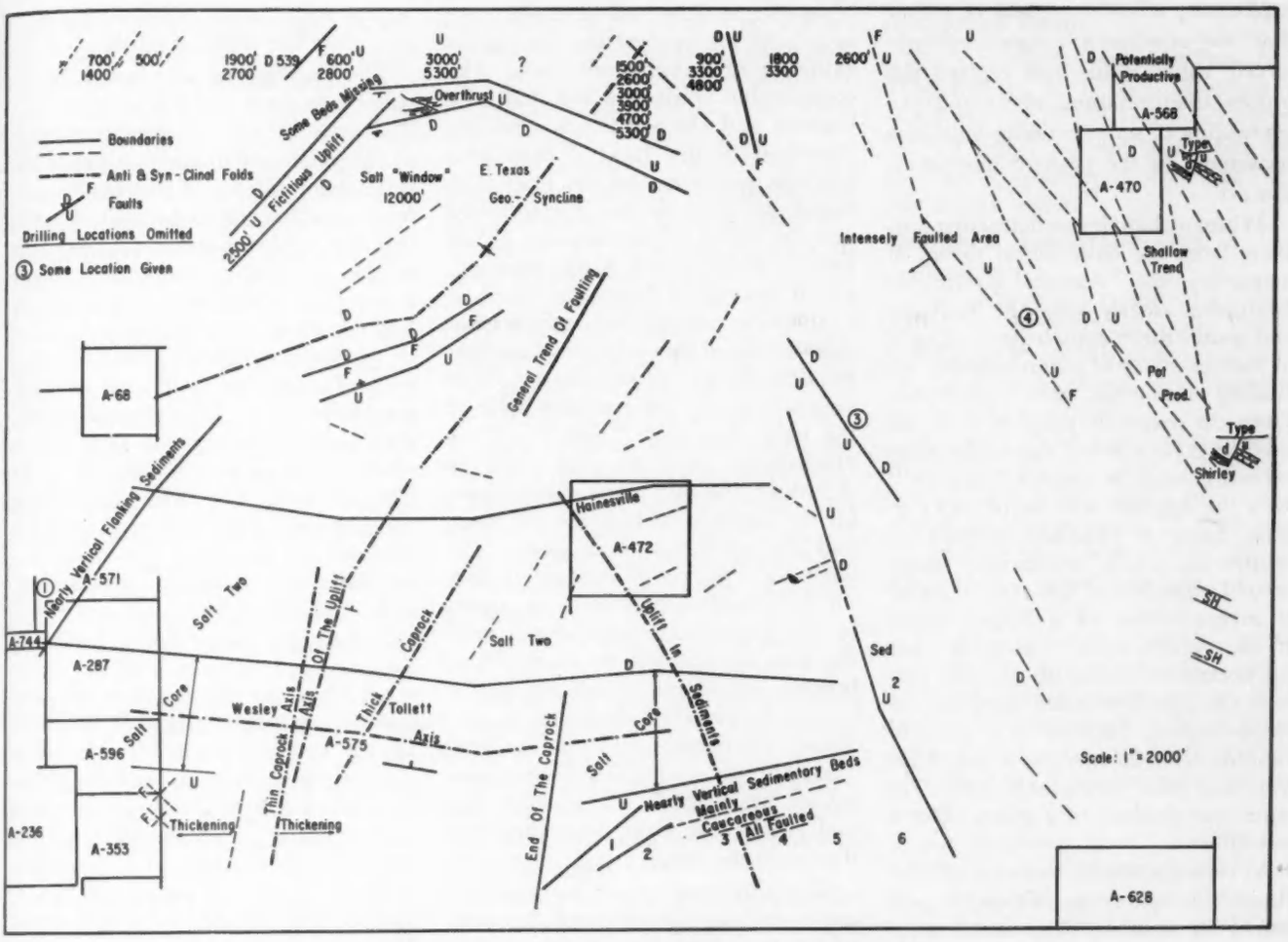
Amerada Petroleum Corporation's Fred O. Smith No. 1, C NW SW/4 Section 21-24n-13w. Top of Hunton formation 7176 feet (—5759 feet). Drill-stem test from 7179-7199 feet (—5762 to —5782 feet). Testing tool open for four hours; recovery in drill pipe, 110 feet of mud and 738 feet of salt water.

Amerada Petroleum Corporation's R. Morgan 1, C SE NE/4 Section 20-24n-13w. Top of Hunton formation

Continued on Page 115

Table Formation Marker Summary, Individual Wells, Oakdale Field, Woods County, Oklahoma, Amerada Petroleum Corporation Wells

FORMATION MARKER	W. H. Farris 1 C SW NW/4 Section 21 (Ft. Subsea)	J. N. Hansen 1 C SE NW/4 Section 21 (Ft. Subsea)	R. E. Copenhaver 1 C SW NE/4 Section 21 (Ft. Subsea)	F. O. Smith 1 C NW SW/4 Section 21 (Ft. Subsea)	R. Morgan 1 C SE NE/4 Section 20 (Ft. Subsea)	H. Hansen 1 C SE SE/4 Section 17 (Ft. Subsea)
Osage Layton sandstone	—4014	—4006	—4035	—4045	—4026	—4038
Hogshooter limestone	—4142	—4147	—4150	—4170	—4164	—4177
Oswego limestone	—4156	—4359	—4366	—4379	—4379	—4391
Cherokee zone	—4499	—4498	—4675	—4669	—4674	—4679
Cherokee sandstone	—4644	—4645	—4691	—4691	—4680	.....
Base Pennsylvanian—Top Miss.	4699	.....	4724	—4743	—4734	—4743
Woodford shale	.....	—5639	—5649	—5684	—5667	.....
Hunton formation	—5691	—5687	—5691	—5759	—5738	.....
Sylvan shale	.....	—5768	—5775	—5831	—5812	.....
Viola limestone	—5867	—5859	—5856	—5924	—5904	.....
Simpson dolomite	—6018	—5971	—5978	—6007	—6019	.....
Simpson sand	.....	—6013	—6015	—6091	—6061	.....
Arbuckle formation	—6288	N.R.	.....	.....	.....	.....
Total Depth	—6715	—6151	—6087	—6088	—6187	—4945
Completion Date	11-17-55	3-22-56	9-6-56	5-31-56	5-17-56	6-28-56
Producing Formation	Simpson sand —Oil	Simpson sand —Gas	Simpson sand —Gas	Cherokee sand —Gas	Cherokee sand —Gas	Layton sand —Gas
Elevation k. b.	1414	1409	1412	1417	1416	1413



Magnetic survey—map of surface projections, Wood County, Texas.

New Method Indicates Productive Area

A revolutionary interpreting method greatly enhances exploratory findings gathered with conventional magnetic devices.

By MARK MILSTEIN
Consulting Geophysicist
Grand Junction, Colo.

THE ADVANTAGES of a new approach in magnetics, well shown by the discoveries of productive reef-limestones in the U. S. and Canada, leads to the introduction of four attractive Hainesville Dome locations where the structural and stratigraphic conditions warrant the expectation of prolific production.

Accumulated evidence supports the writer's findings that magnetic characteristics of sedimentary rocks are sufficient to create measurable contrasts which can be evaluated. Thus, the strength of magnetic method, under-rated or not understood by casual observers, lies, not in the obvious, largely regional variations of magnetic fields, which may serve as points of departure for interpretation, but in the minute cumulative effects of vertical intensities. The small measurable differences reflecting the influence of localized features are the essence of the method. Such indications, properly interpreted, bring out the structural and stratigraphic variations of the whole geological set-up.

The principles of splitting the observational curve into magnetically uniform "domains," so long neglected in literature or practical application, instead of unwarranted assumption of a unique magnetic field, pays off handsomely and therefore is worth pursuing in every, however difficult,

exploratory effort. It should be added that the routine adjustment of observed values could not replace the proper interpretation, nor could the contouring of some fictitious values be considered as the peak of interpretative art.

Without changing or detracting anything from the basic Gauss theory of magnetics, the "domain" principle establishes clearly why the intrusive and sedimentary complexes may exist in various states of magnetization, including a neutral (zero) position. From the magnetic point of view, all existing matter being randomly magnetized belongs to various "domains"; even the smallest volume of rocks or beds, being a possible magnet or magnetoid, could be variably magnetized regardless of the general status of magnetization of a large volume of the earth's crust. "Domains" are not necessarily uniformly aligned; and with casually distributed directions of magnetization, such as in a pack of variably oriented needles, it may happen that the measurable effect of same may produce in a given place a zero effect.

A reconnaissance survey of the Hainesville salt dome (Texas) is presented as another demonstration of the validity of the "domain" principle which brings out directly the relationships between the stratigraphic and magnetic values; thus enhancing the resolving capacity of this new technique. The originally published map and report written in 1952, long before the present interest developed, is quoted verbatim. Some nonessential details are omitted.

The Hainesville salt area was known for years, but the discoveries made in the adjacent Pine Mills area by the writer, leading to production on faulted closures, attracted attention to the possibilities of westward situated areas. The Hainesville survey was conducted to evaluate the environmental conditions and to pinpoint the areas of interest.

In a reconnaissance survey, not all details could be worked out, nor could the position of the horizontal discontinuities (writer's formulae) be evaluated correctly; but the general subsurface conditions as shown on the map were firmly established. The geological information at this time was practically nonexistent, nor were logs of a few dry holes in this district procurable. Nevertheless, the pattern of faulting in Pine Mills area was very suggestive for anticipating the nearby existence of a large salt body. The considerable uplift of a salt mass, the caprock and the sediments, also, the position of the East Texas geosyncline, are noted on the map. The major influence is the configuration and the extent of the salt core ("Salt One"), which is not of the common, round, dome-like shape but which is a narrow (in places) assymetrical plate squeezed into a faulted east-west trending fissure in sediments. The area affected by the uplifting drive of the intrusive salt ("Salt Two") is much larger than the core itself, as shown on the map. The down-throw for the fissure is north of the salt mass, and the up-throw is in south. The writer is under the impression that the deformations present in the structurally insignificant northwest part of the area are caused by another flat-bedded salt layer ("salt window") at much greater depth than the Hainesville dome, possibly at the limit (12,000 feet) of the resolving capacity of the method. The correct dips and strikes for some horizons are shown on the map.

The shortcomings of survey are quite obvious: Insufficient coverage of the examined area permits only a wide spread of grid observations; whereas, in the proper survey, the traverses should be not more than 1000 feet apart. Thus, the correct tracing of identical elements of the stratigraphic or structural make-ups was impossible. Breaks in the observed lines, caused by non-accessibility, etc., hinder also the correct evaluation of depths; nevertheless, with such insufficiencies, the survey projects on the surface all the above-cited features.

The discovered (by drilling) overhang was not determined previously unless "Salt Two" reflects its extent; the depths to Woodbine formation calculated in some places as 5600 feet, may be too small, reflecting the effects of some other discontinuity. The potentially productive areas, now partly omitted, remain as originally plotted, though the order of suggested drilling is changed. The salt core position was given originally. The nearly vertical flanking positions of the sedimentary beds, mainly of calcareous nature, were determined for the southern and northern flanks. The situation on the northwestern flank differs considerably from the same in south.

The investigated area could be divided into three distinct entities: (1) The intensely faulted northeast block of the relatively shallow (about 6000 feet) deformations of practically uniform northwest strike and dipping variably northeast and southwest. This is the area of narrow intermittent zones of production controlled by faulted anticlines with closures worthy of further exploration. Detailed surveys of this area will lead to new discoveries. (2) The deepest northwest part, including the East Texas syncline, of doubtful interest. (3) The southern salt area of greatest commercial value. The shallow beds obscure the fact that the whole investigated area is underlain by a deeplying (11,000-13,000 feet) salt bed spreading far beyond the limits of the survey. In places, this salt mass approaches the surface in a step-like fashion, and this approach accounts for the localized uplift affecting in a particularly prominent way the Wesley Tollett survey. Following close to a north-south trend of uplifting, this salt may come close to the surface somewhere in the south, unless it plunges once more back into abyss. The salt of the examined area occupies the crestal part of a faulted fissure in the sedimentary column and spreads over a large area outlined on the map. The irregularly faulted sedimentary blocks, as exemplified by the pattern of marked boundaries, emphasizes the disarray of conditions worked up by the salt extrusion. On the uplift, salt reaches a very shallow position of 500-900 feet, thus forming the shallowest zone of the so-called "Salt One." "Salt Two" lies slightly deeper (1200 feet).

Caprock of irregular shape and thickness is shown on the map, where the position and trend of its thickest part is given. The writer cannot escape a feeling that a similar intrusion, but at much greater depth ("salt window") exists somewhere close to the East Texas synclinal axis.

There are many gradual and sudden changes in depths, ranging between a close approach to the surface and deepest position of salt; the shown intraformational boundaries help to visualize the position of every deepening zone. Between the northwest "overthrust" and the northern salt

boundary, there exists a graben-like depression (or a marginal syncline) accommodating a considerable thickness of sediments; the structural configuration of this area is influenced by the variable thickness of same sediments and the differential upthrust of the basal salt blocks. With the sedimentary column overlying the deep salt, contortions in the sediments are unusually gentle, and the deepest detected structure at 8500 feet is probably in the Travis Peak formation, as noted in northeast. On the approach of salt to the surface or with the thinning of sediments, the beds become disturbed, upturned, and in some places (shown on the map) stand up practically vertically.

Outside the main regional north-south trend, there are other structurally attractive deformations; but the scarcity of observations prevents their correct evaluation. The numerous rim synclines are not continuous.

The most calamitous results are produced by the abrupt changes in the position and attitude of salt masses; great volumes of sediments are shattered and sheared, thus ruining many potential oil traps (or creating new ones). Displacement of vast amplitudes through intense faulting, noticed in the north-east area, give an idea of the actual conditions. Similar deformations, at greater depths, were more attenuated, thus leaving place for the preservation of better trap conditions.

The area of maximum uplift is cut by a series of radial and tangential gravity faults of Upper Cretaceous time, with a rare exception of a thrust fault, marked on the map; post-Cretaceous faults of variable trends intersect the salt core and continue into shallow sediments. Other high-angle (not less than 58°) faults, outside the uplift, strike with marked regularity North 45°—65° West and dip 45° with downthrow on northeast. Some faults are of complex nature due to termination of several of the faults against others. In general, the displacements are large (over 200 feet and more), thus developing important closures. The calculated depths for various unnamed discontinuities are scattered all over the map, but they could not be correctly linked for the reasons stated above. The most probable depth to Woodbine formation is 5600 feet, to sub-Clarkville—4600 feet, and to Pecan Cap—2700 feet. With the havoc wrought by the uplifting movement of the core, the depths could vary considerably and in a remarkably short distance.

There is a good selection of possible traps; and the productive possibilities, except in shallow sediments, should be excellent, particularly in flanking positions around the salt. The ridge on the salt core may serve as a target, but much better opportunities are existing on high-flanking positions in the sediments or within the faulted closures scattered all over the area as updip terminations of reservoirs by faulting. The presented evidence bears a marked resemblance to the structural setting of the old Van field situated on the western flank of East Texas syncline at slightly different depth.

The main producing objective is expected to be in the Woodbine beds, the basal part of the upper Cretaceous series; simultaneously, in appropriate flanking conditions, the shallower sub-Clarkville beds could also be productive; and even the upper Pecan Cap beds may be considered sometimes as a worthy target.

Contrary to the common practice of reviewing the history of productive but exhausted pools, the writer breaks with tradition of "post-mortem" reporting and submits, as a test of the new exploratory technique, four promising areas selected for drilling as follows:

1. Five hundred feet south from NL and 330 feet east from WL of V. Hobbs Survey, Abs. 287, or 330 feet west of WL of same Abs. 287;
2. Twelve hundred feet east from WL and 800 feet north from SL of A. M. Loyd Survey, Abs. 359;
3. Two thousand eight hundred feet east from WL and 3500 feet south from NL of N. L. Burnett Survey, Abs. 34;
4. One hundred sixty-five feet east of WL and 2700 feet south of NL of D. C. Bradford Survey, Abs. 35.

Note: Location 1 and 2 are on uplifted flanking setting; and 3 and 4 on faulted closures.

It would be highly gratifying if the suggested locations would encompass the future development of productive pools in this vastly promising district, as previsioned by this survey.

—The End

Anadarko Basin

Continued from Page 112

7154 feet (—5738 feet). Drill-stem test from 7161-7195 feet (—5745 to —5779 feet). Testing tool open for two hours; recovery in drill pipe 180 feet of salt water.

Cherokee Sandstone Gas Reservoir

Commercial gas production was discovered at the structurally lowest well on the south side of the field during May, 1956, from the Cherokee sandstone gas reservoir.

Amerada Petroleum Corporation's Fred O. Smith 1, C NW SW/4 Section 21-24n-13w, was originally drilled to a total depth of 7505 feet in the Simpson series of Ordovician age where it tested salt water in the Simpson formation.

However, Smith 1 was plugged back to the Pennsylvanian and a string of 5½-inch casing set at 6184 feet in the Mississippian Chester limestone. Casing was perforated for completion in the Cherokee sandstone as follows:

Top of Cherokee zone .....6086 feet (—4669 feet)

Top of Cherokee sandstone . 6108 feet (—4691 feet)

Perforations from 6110-6114 feet with 16 shots; 6120-6128 feet with 32 shots; acidized, fractured, flowed 338 barrels of load oil with 3,585,000 cubic feet of gas in 18.5 hours. Completion gage 3,800,000 cubic feet of gas per day through ½-inch tubing choke.

Layton Sandstone Gas Reservoir

The fourth gas reservoir to be proven productive at Oakdale field is the Layton sandstone of Pennsylvanian age found about 640 feet above the Cherokee sandstone.

On the northwest outpost of the field, Amerada Petroleum Corporation's Harold O. Hanson 1, C SE SE/4 Section 17-24n-13w, was completed on June 28, 1956, for an initial gage of 900,000 cubic feet of gas per day. Completion was made through casing perforations with 12 shots from 5441-5444 feet and with 20 shots from 5451 to 5456 feet. Production test followed reacidization. Layton sandstone was originally found at a depth of 5451 feet (—4038 feet).

Originally this well was carried to a total depth of only 6358 feet in Mississippian limestone encountered at 6338 feet.

—The End

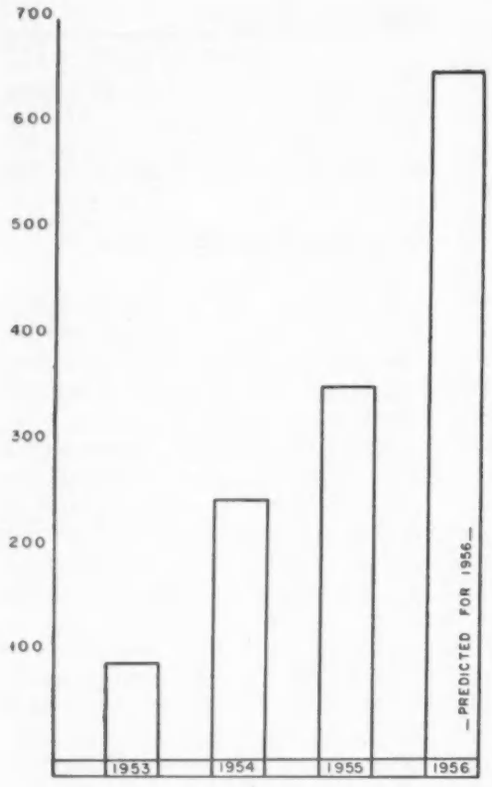


FIGURE 1—Gulf of Mexico, offshore completions, 1953 to 1956.

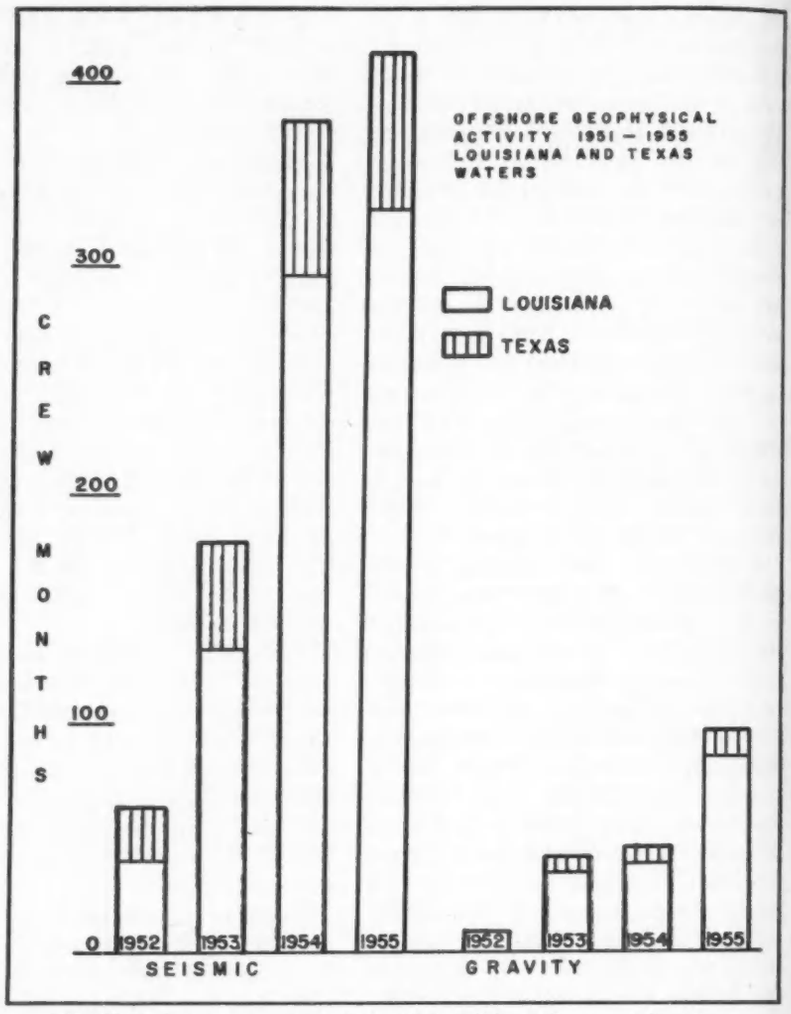


FIGURE 2—Increase in geophysical activity offshore Texas and Louisiana.

Areas of Interest in Marine Oil Prospecting

Exploration of marine oil reserves in the near future will be most promising in those areas where sedimentation has been continuous throughout the Tertiary and where the present seas are remainder of major Mesozoic and Tertiary geosynclines.

By T. R. GOEDICKE
Director of Research
Offshore Exploration Group, Inc.
Houston

THE PAST TEN years have seen a tremendous increase in interest directed toward marine areas of the world. This activity was originally initiated by oceanographers who had studied sediments of deep and shallow seas as well as the physical and biological processes in the ocean. Recently, this interest has been taken up by the oil industry and their investigations have led to the discovery of numerous oil fields situated in marine areas around the world. Three notable examples of the marine oil industry development are the fields of the Persian Gulf, Venezuela's Lake Maracaibo and the Gulf of Mexico's continental shelf. Rapid development of the marine oil industry in the latter region is shown in Figure 1, which indicates the number of marine oil well completions during the past year.

A study of the marine oil industries in the Gulf of Mexico, which is indicative of the future progress of

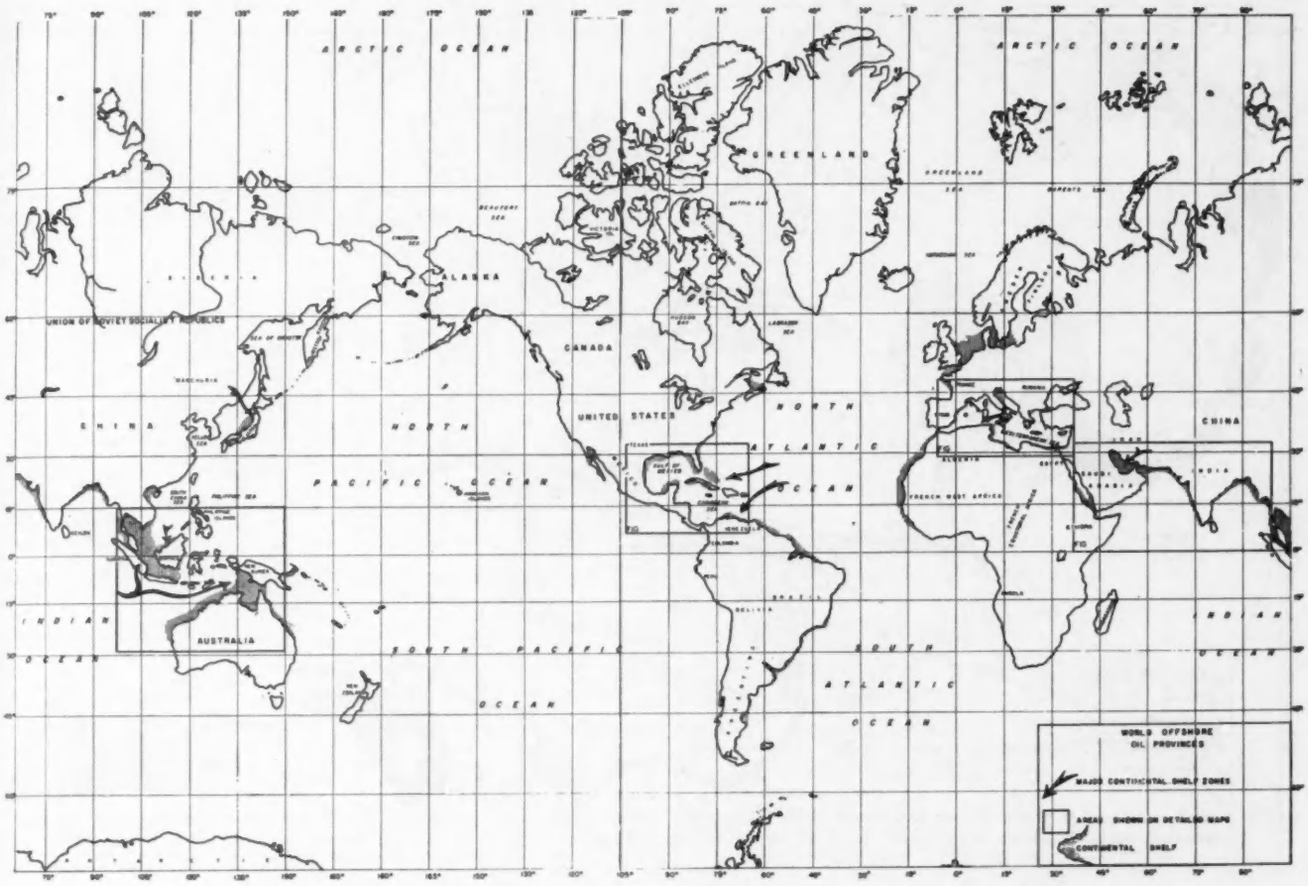


FIGURE 3—Index map of the world showing areas of Cretaceous to Recent geosynclines and epicontinental seas.

marine oil around the world, reveals the nature of the study which has led to the development of a complex industry.

The approach to the discovery of the marine oil reserve is threefold:

- First, study of stratigraphy of adjacent land area. In the case of the Gulf of Mexico, this has suggested the continuity of the rich petroliferous sediments of South Louisiana and Texas beneath the continental shelf.
- Second is geological oceanography. The importance of this field is emphasized by the principle of continuity which states that sedimentary processes going on at present have been continuous in the past. The necessity for study of sedimentation has led to exploration by oceanographic means of the recent sediments along the coasts and in the shallow seas of the continental shelf of the Gulf of Mexico.
- Third, is geophysics. It is well known that no oil production can be discovered, even in an area of rich petroleum source beds, unless appropriate structure traps are present. It has been the role of exploration geophysics to determine these structural traps both on the coastal plain of Texas and Louisiana and on the continental shelf of the Gulf of Mexico. Figure 2 shows the recent increase in geophysical activity in the offshore areas of Texas and Louisiana.

It is interesting to note that exploration by drilling in the Gulf of Mexico has led to a success ratio of 42 percent. This unusually high degree of success is ascribed to the rather concentrated use of exploration geophysics in the Gulf of Mexico together with the unusually favorable stratigraphy of the area.

The upper Mesozoic and Tertiary to Quaternary stratigraphy of the coastal plain of Texas and Louisiana and the adjacent continental shelf is characterized by almost continuous deposition. This has been interrupted only briefly by periods of emergence. Thus, the sea covering the present continental shelf of the Gulf of Mexico is but a remainder of the somewhat greater expanse of Tertiary seas which covered a great part of what is now the coastal plain of the southern and southwestern U. S. This fact leads to speculation regarding other marine areas in the world where geosynclinal conditions of deposition have been continuous from the Mesozoic to the Recent. Such areas may form future marine oil provinces similar to that of the prolific continental shelf of the Gulf of Mexico.

Figure 3 shows an outline map of the world indicating some of those areas. A few of the better known Tertiary geosynclinal zones are illustrated by a series of detailed maps.

Caribbean. The best known areas of continuous deposition throughout most of the upper Mesozoic and the Tertiary are the Gulf of Mexico and the bordering continental shelf and land areas shown on Figure 4. Figure 5 shows the generalized stratigraphic correlation chart of the near shore sedimentary basins surrounding the Gulf of Mexico and Caribbean. Those stratigraphic horizons which are known to produce petroleum or which are believed to be petroliferous are indicated on the correlation chart.

The sedimentary facies along the northwest edge of the Gulf of Mexico

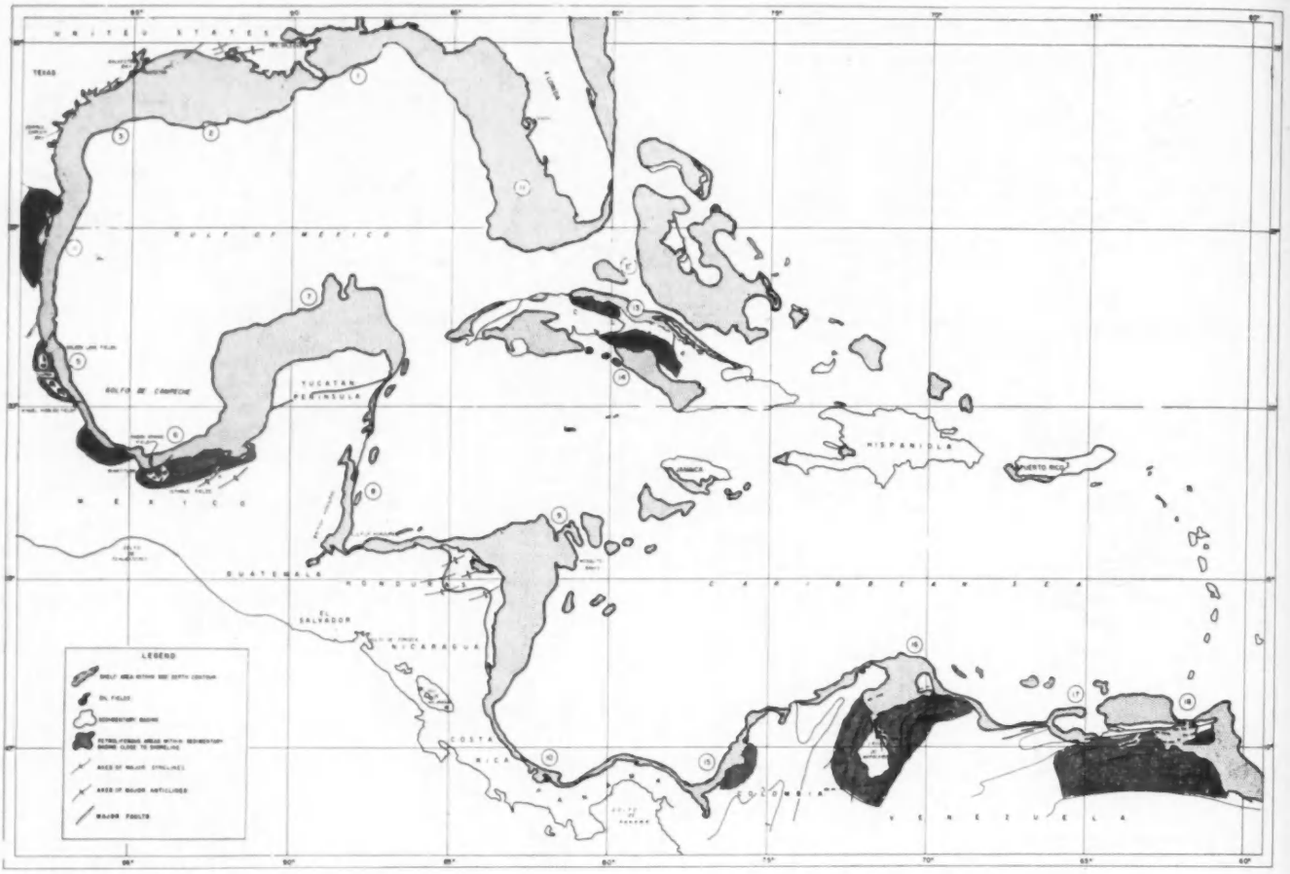


FIGURE 4—The Gulf of Mexico and the Caribbean showing the continental shelf areas. Petroliferous sedimentary basins are shaded.

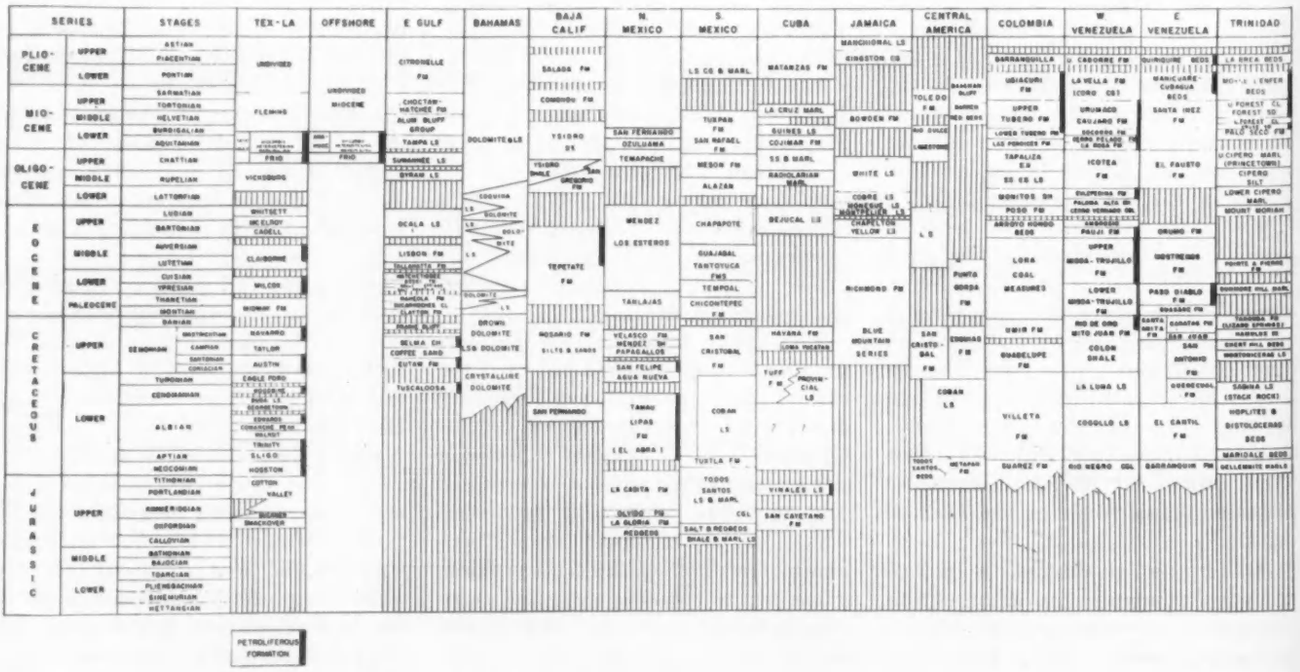


FIGURE 5—Correlation chart of the oil bearing formations in countries surrounding the Caribbean.

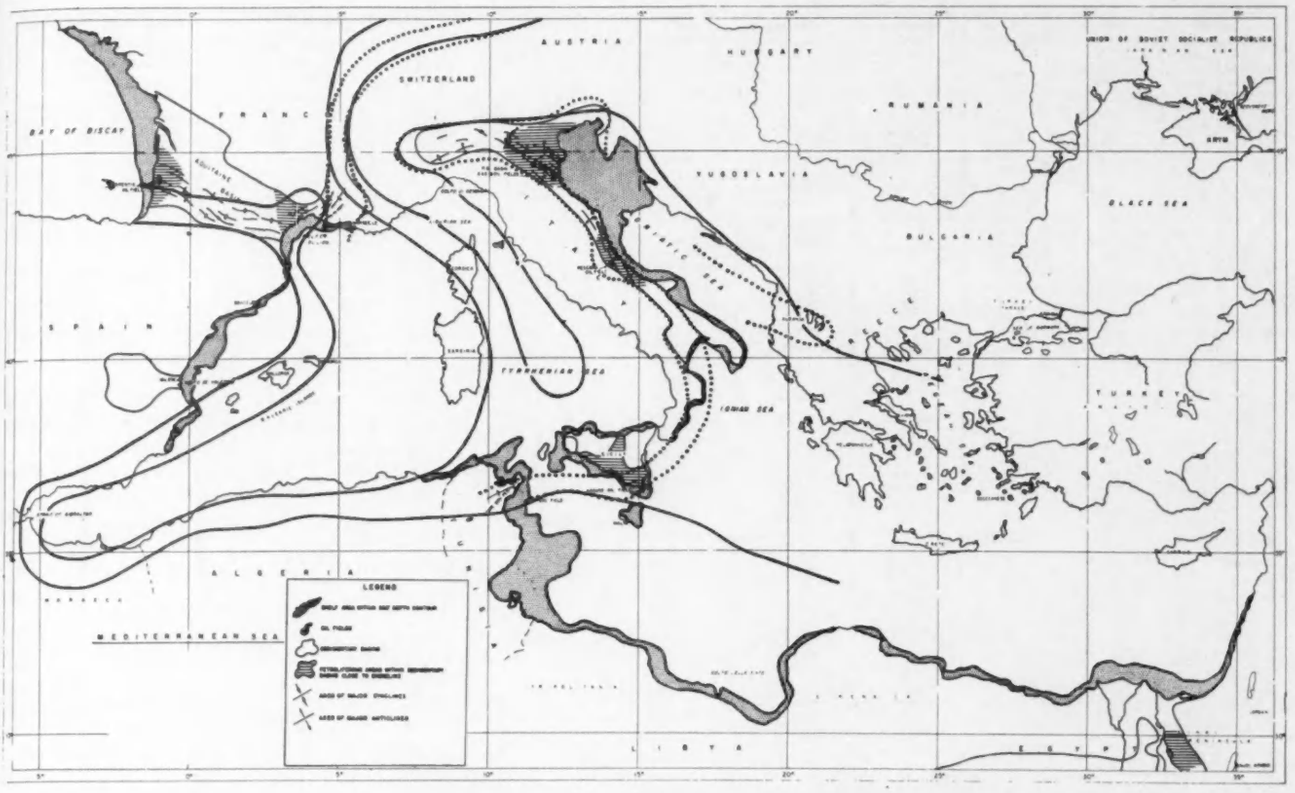


FIGURE 6—The Mediterranean area and surrounding countries, showing continental shelf areas and petroliferous sedimentary basins. Heavy line indicates the limits of geosynclines in the early Tertiary. Dotted line shows limits of geosynclines during the late Tertiary.

is chiefly one of clastic sediments derived by erosion of the North American continent. It is here that the most prolific marine oil production is found at present. A limestone facies predominates in the eastern part of the Gulf of Mexico and in the Caribbean area northeast of Cuba. A limestone facies is also found along the Gulf Coast of Mexico and Central America, especially in the Peninsula of Yucatan. This limestone facies which has been tentatively correlated with that of the eastern Gulf, is productive in Mexico and nearshore in the Isthmus of Tehvantepeo.

Recent investigations have suggested that Mesozoic Tertiary deposition was continuous across the entire Yucatan Peninsula as well as the Campeche banks. These constitute a large shallow marine area which may easily become a major offshore oil province. Other geosynclinal areas show which Tertiary sections are found along the north coast of South America. Notable in this region are Lake Maracaibo, the Gulf of Venezuela and the Gulf of Paria regions.

The Gulf of Venezuela and Lake Maracaibo occupy a depositional basin which has been in existence throughout most of the Cretaceous and Tertiary. This major depression which can be termed a eu-geosyncline is situated between mountain ranges to the east and west. Considerable petroleum production has come from a part of this basin and stratigraphic studies appear to indicate the likelihood that the petroliferous formations are present in all of this geosyncline.

The Gulf of Paria and Orinoco River delta area is, like the Lake Maracaibo depression, situated between mountain ranges. The sea which occupies this area at present, extended during the Tertiary into the Orinoco River basin and across most of eastern Venezuela. Here apparently we have another case of continuous deposition in a marine basin from which the seas have withdrawn only recently. From this it is possible to conclude that the petroliferous formations may be present throughout the entire basin and under the Gulf of Paria.

Europe and Far East. Two examples of idio geosynclines are found in Europe and the Mediterranean Sea area are shown on Figure 6. The Mediterranean in itself is the vestige of the large sea of Tethys, which stretched during the Tertiary from India to Gibraltar. Great thicknesses of Tertiary sediments accumulated in that sea and were folded to form the Alpine chains. During the Upper-Tertiary, a large arm of the Mediterranean extended across upper Italy, continuing through Switzerland into southern Germany. This was the sea in which the so-called Mollasse sediments were deposited. These have been found to be petroliferous in southern Germany. The oil and gas bearing sediments of the Po River basin were also laid down in this area.

The present Adriatic Sea is the last remainder of this major Tertiary arm of the ocean and it is believed that the Adriatic will form a marine province of the future.

Deposition in part of a Tethyan Sea is also characteristic of the region of the prolific oil fields in Arabia. Sedimentation in this region has been almost continuous from the Jurassic to the Recent. The stratigraphy of this region, as that of the Po region, is shown on Figure 7. The Persian Gulf itself is a vestige of the Cretaceous and Tertiary Seas which deposited the oil bearing formations of Saudi Arabia, Iraq and Iran. That petroliferous formations are continu-

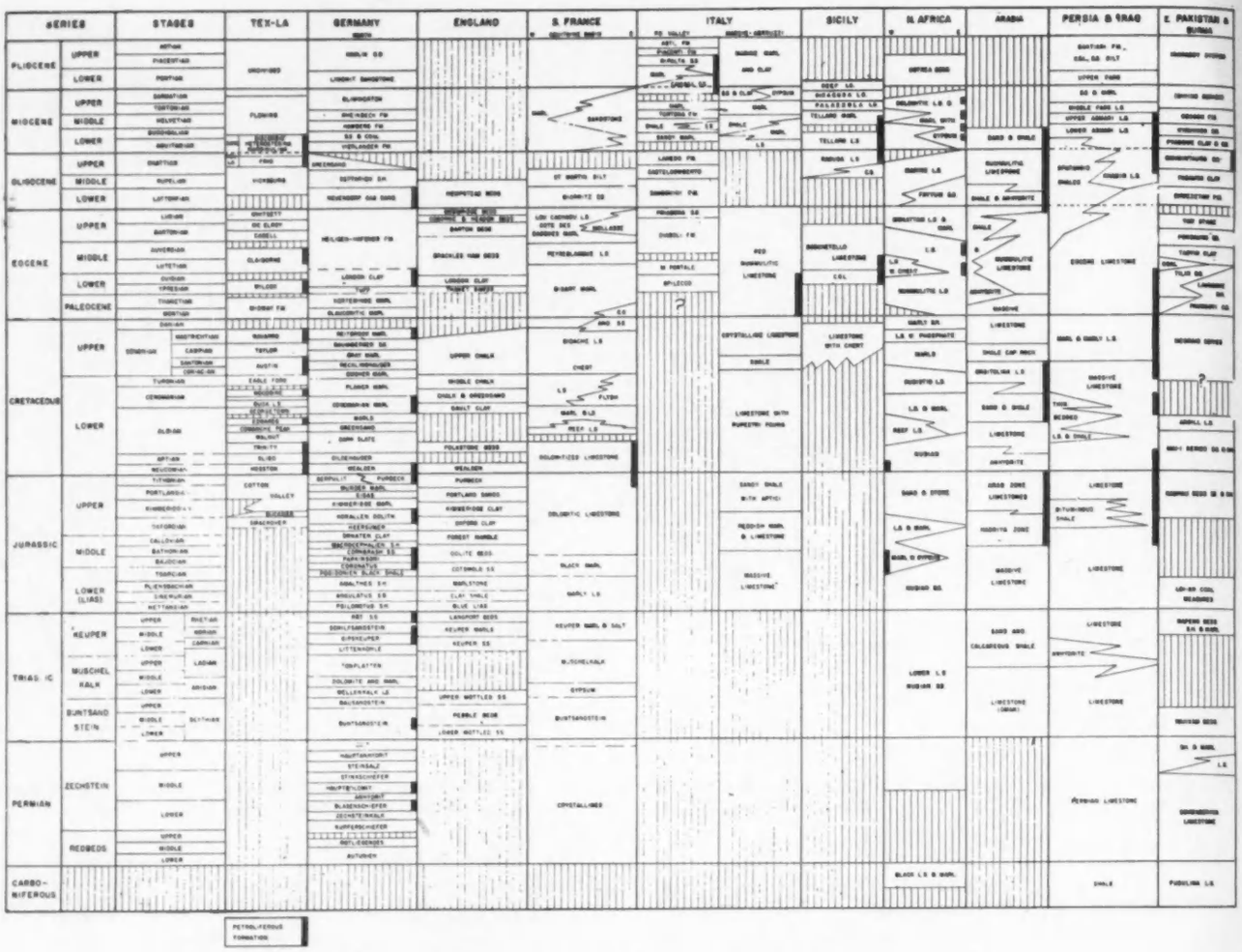


FIGURE 7—Correlation chart of the European, Mediterranean and Near East sedimentary basins.

ous in this sedimentary basin beneath the Persian Gulf is proven by the Safania oil field situated 20 miles off the coast of Saudi Arabia.

The above are only a few examples of areas where geosynclinal deposition in relatively shallow water has been continuous throughout the upper Mesozoic and Tertiary and where shallow seas are still present. Such areas are believed to offer the best chances of locating prolific offshore oil production. These areas also offer excellent material for study of the sedimentation processes which have been continuous throughout geologic time and which have led to the formation of petroleum deposits.

Exploration for marine oil reserves in these areas is being actively carried on by the best methods available. The following will outline a few of the recent outstanding developments which will be used in exploring these possible future marine oil provinces.

Exploration falls into two major groups:

- Geophysics
- Sedimentation

Geophysical methods of exploration are equivalent to studies of geological structures in land areas. Since the recent sediments found on most continental shelves show only a very slight reflection of the underlying structures all studies of deep-seated structures which might be possible oil traps are carried on by means of geophysics. Many recent advances have been made in geophysics and a few will be described here. Geological and sedimentation studies in recent marine basins and on the continental shelves, are exceedingly valuable in teaching the geologist about the processes of sedimentation of the past and the results of changes of sedimentary facies. The study of sedimentary facies relationship has reached increasing importance due to the fact that the oil industry has recognized the prevalance of stratigraphic type oil traps. Studies of recent sediments are carried on by geologists and geological oceanographers.

Geological Oceanographs. The instruments and methods employed by the geological oceanographers are some of the following: samples of bottom sediments are obtained by means of piston probing tubes, with grabs or dredges. The particular device depends upon the depth of the water and the use to which the information from the samples is to be applied. The samples are examined for grain size distribution, mineral content, percent $CaCO_3$, fossils and organic matter.

Coring tubes are built to take cores from 6 inches to 60 feet in water up to four thousand feet in depth. These coring devices retain a sample in a plastic tube held within the tool thus

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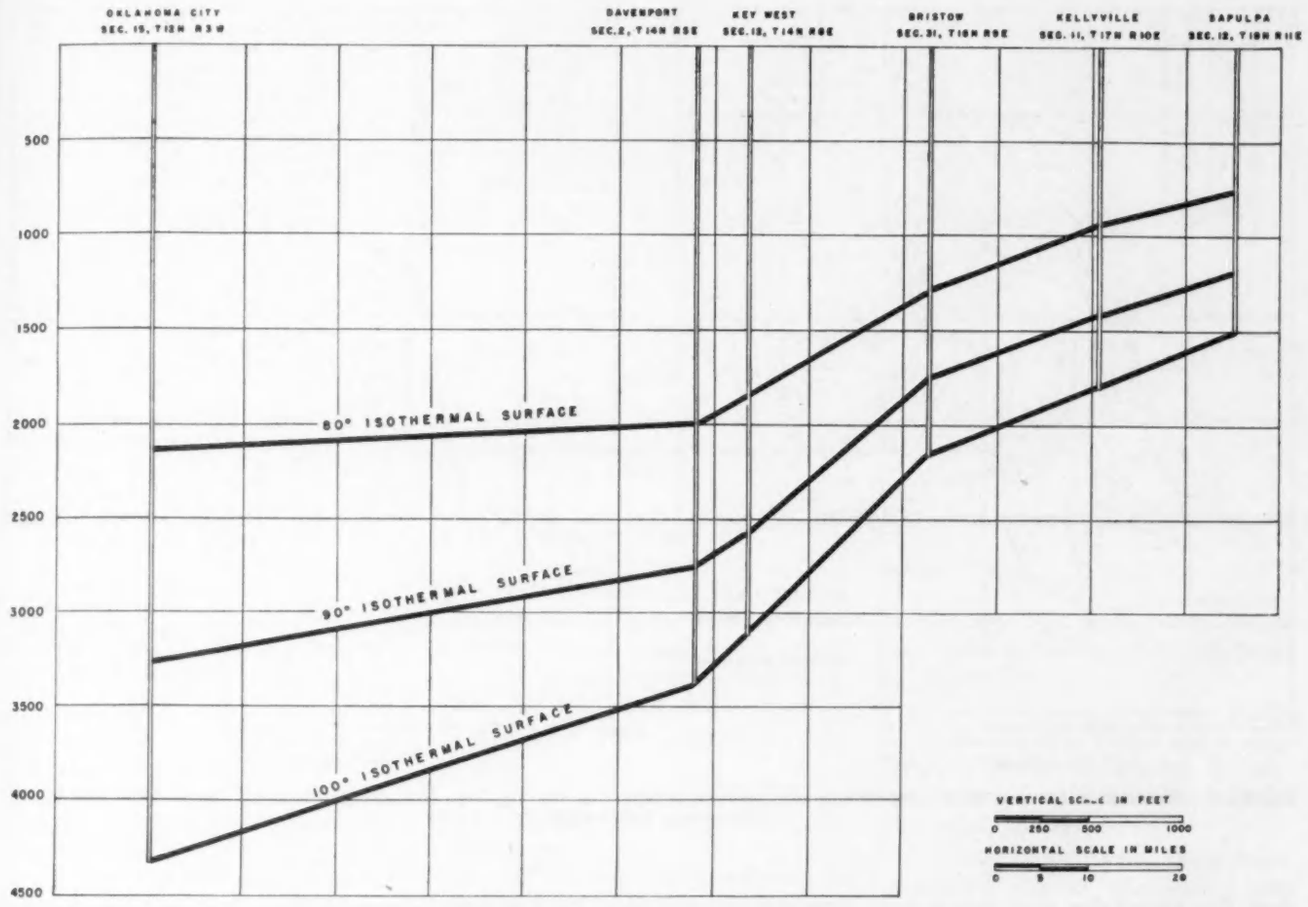

FIGURE 1—Temperature Cross-Section—Oklahoma. Profile in Oklahoma showing the changes in earth temperatures from east to west along the profile. After McClutchin, API Production Bulletin 205.

Surface Alteration Utilized in Structural Mapping—A Function of Earth Temperature

By BERNARD H. LASKY
Consulting Geologist
Houston

EDITOR'S NOTE

Studies of the relation of earth temperatures to geologic structure were made in the U. S. as early as 1926. API completed an extensive investigation of earth temperatures in oil fields during 1930. These investigations indicated that surface and near-surface temperatures reflected geologic structure. The highest temperatures were found over the crests of anticlines and domes and temperatures were progressively lower on the flanks. The possibilities of geothermal prospecting were suggested. In Part 1 of this two-part report, the author reviews previous findings in this field to prepare the reader for a complete understanding of Part 2, which introduces more recent, indicative findings in the field of temperature-structure correlation.

As EARLY as 1920, it was known that surface and near-surface temperatures, in some instances, reflected subsurface structure. It has been found that high temperatures were associated with the crests of anticlines and domes and that temperatures were progressively lower on the flanks of these structures.

Van Orstrand[1] in 1926, indicated that investigations of temperature-structure relations at Ferris Dome, Lance Creek, Salt Creek, Lost Soldier and Thermopolis, Wyoming, and at Coalinga, California, pointed definitely to the conclusion that higher temperatures occurred over the apex of these anticlines at depths of from 100 to 1500 feet, than temperatures on the flanks and that these variations in temperature reflected the subsurface structure at a depth of 3000 feet. It should be noted that the average depth of wells drilled in the U. S. in 1930 was 2900 feet.

In the introduction to "Earth Temperatures in Oil Fields,"[2] K. C. Heald referred to evidence prior to 1926 which showed that subsurface structure was reflected by surface and near-surface temperatures and noted

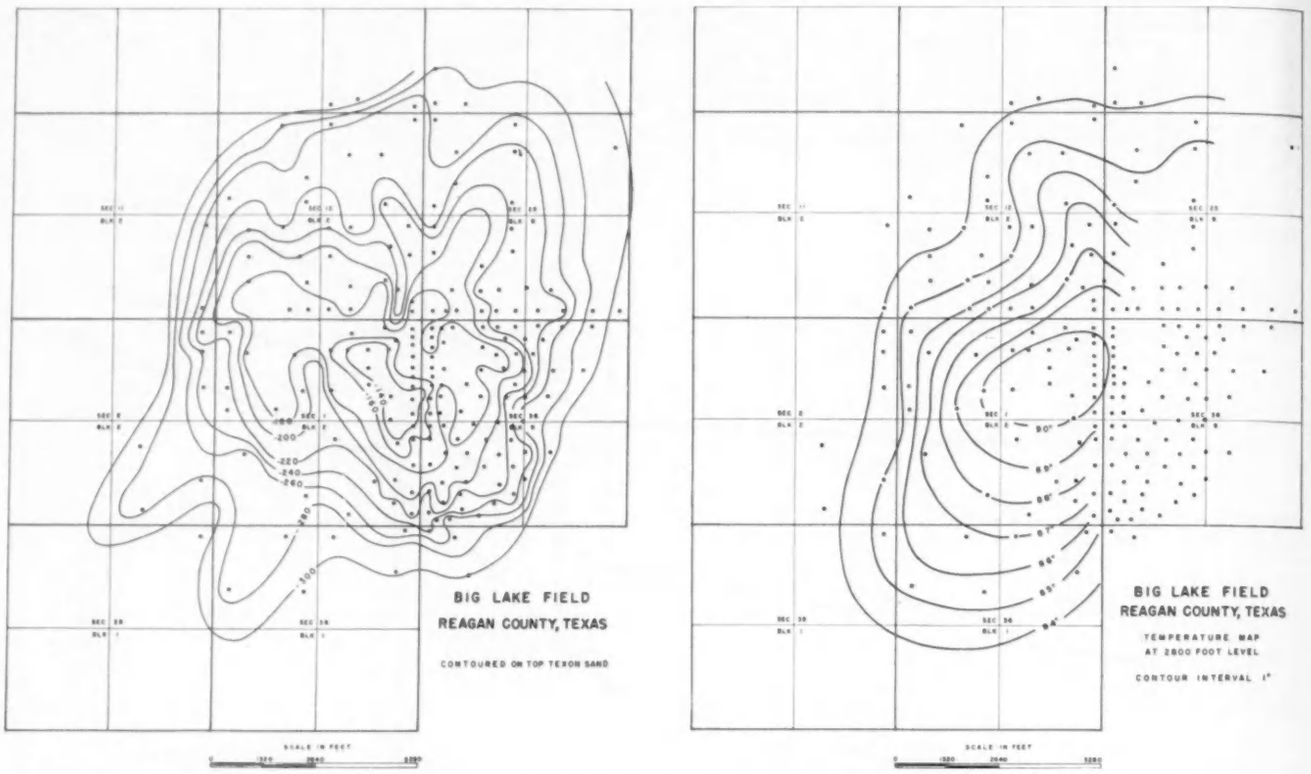

FIGURE 2—The relation between earth temperatures and geologic structure in the Big Lake field, Reagan County, Texas. After Hawtof, API Production Bulletin 205.

that this knowledge was responsible for the initiation of the API Research Project No. 25 in 1926, the results of which have been described in Bulletin 205.

The purpose of Project No. 25 was to determine the conditions responsible for variations in the rate at which temperature increases with depth and to study the relations between earth temperatures and both regional and local geologic structure.

Project No. 25 was administered by the Institute with the cooperation of the Central Petroleum Committee of the National Research Council. The U. S. Geological Survey was associated with the project and C. E. Van Orstrand, physicist for the Survey and an outstanding authority on earth temperatures, assumed an important role in the investigation.

The importance of Project No. 25 cannot be over-estimated. It has provided a considerable amount of valuable information for the physicist, the petroleum engineer and the geologist. The significance of the project may have been lost to some extent by the geologist in recent years because of two different factors. The geologist has not had the opportunity to utilize earth temperatures as an operating tool and Project No. 25 was completed 26 years ago and literature on the general subject of earth temperatures has been extremely limited since 1934.

It is for these reasons that the results of the API investigation and previous geothermal studies are briefly summarized and re-emphasized.

In his introduction to API Bulletin No. 205, Heald states, (a) it has been recognized that temperatures increase with depth, (b) European students advanced the theory that the presence of oil may be indicated by abnormally high temperatures and (c) in the U. S., it has been considered that temperatures were possibly related to geologic structure, changes in stratigraphy, ground water circulation and other pertinent geologic facts which may be of assistance to the geologist in the search for oil and gas and in the determination of the limits of oil fields.

Summary of Results—American Institute Project No. 25

Project No. 25 was confined for the most part to those areas in Oklahoma, Kansas, Texas and California where it appeared that the results might definitely establish the relation between earth temperatures and geologic structures, both on a regional and local basis.

• Investigations of Temperature in Oklahoma

The investigations in Oklahoma were made by J. A. McCutchin. One of the most significant studies of temperature variations made in Project No. 25 was made by McCutchin who found that temperatures in wells extending in an irregular line from a point between Tulsa and Sapulpa to Oklahoma City, a distance of 130 miles, showed a definite and uniform change over this area. McCutchin found that the highest temperatures were obtained on the eastern extremity of this profile and that temperatures decreased progressively to the west and accordingly, reflected the regional dip of the strata in this area.

Figure 1, reproduced from McCutchin's data, shows that there is a general agreement between the dip of the isothermal surfaces and the dip of the formations. The 80° F. isothermal surface is encountered at a depth of 750 feet near Sapulpa and is 2150 feet deep in the vicinity of Oklahoma City. The temperature data indicates that the farther east

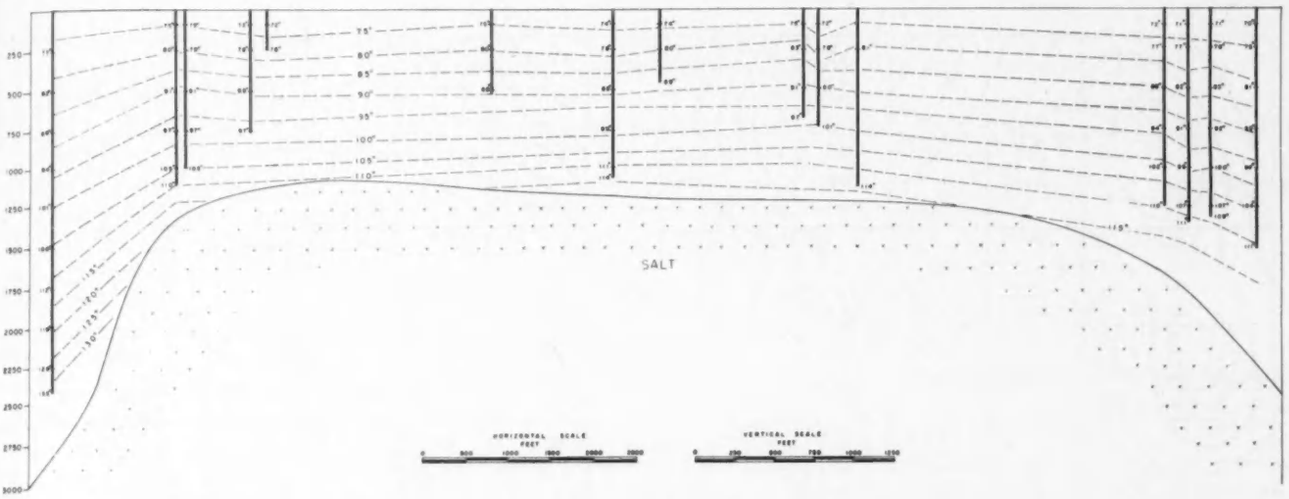

FIGURE 3—Humble Salt Dome—Harris County, Texas. Relation between the structure of the dome and earth temperatures. After Hawtof, API Production Bulletin 205.

and northeast a well is located in Oklahoma, the higher the temperature will be found at a given depth.

An additional and important fact is disclosed by this profile. The isothermal surfaces converge to the east, indicating a gradual increase in the regional temperatures toward the east. In the vicinity of Sapulpa, at the eastern limits of the profile, the 80° F. isothermal surface is 500 feet above the 90 degree surface and the 90 degree surface is approximately 350 feet above the 100 degree surface. At the western end of the profile, the 80 degree surface is 1100 feet above the 90 degree surface and the 90 degree surface is 1000 feet above the 100 degree surface.

An additional project by McCutchin in Oklahoma consisted of the measurement of temperatures in wells extending in a line from approximately eighteen miles east of the town of Okemah, in Okfuskee County to Oklahoma City, a distance of 100 miles. This temperature profile showed a general agreement between the subsurface structure and the dip of the isothermal surfaces and closely approximated the results of the former project.

McCutchin's temperature investigations in Oklahoma on local structure indicated that over a portion of the Cromwell field in Seminole County, there was a marked agreement between the subsurface structure of the field and the isothermal surface at 100° F.

In summarizing his work on temperature in Oklahoma, McCutchin states that the evidence tends to support the general premise that anticlines have higher temperatures at given depths than the surrounding areas.

• Investigations of Temperature in Texas

E. M. Hawtof has described the investigations of temperatures made for the API Project No. 25 in Texas.

On a regional basis, Hawtof indicated that temperature surveys in the Permian Basin of West Texas show a decrease in temperature across the basin. Hawtof states that temperature tests indicate some correspondence between the regional structure and earth temperatures as a result of his investigations in Reagan County, Texas, and in Eddy County, New Mexico. This supports the regional relationship of subsurface structure and temperature established by McCutchin in Oklahoma.

While regional investigations of temperature in Texas were limited, local temperature surveys were more detailed.

In the Big Lake field, Reagan County, Hawtof indicated that there was a marked agreement between the subsurface structure and the variations in temperature. Figure 2 shows the structure of the field on the Texon pay horizon and the isothermal surface at a depth of 2800 feet.

On the Gulf Coast, temperature investigations on the Humble Dome, Harris County, showed that temperatures above the dome were higher than those at corresponding depths on the flanks.

Figure 3 shows an east-west profile across the Humble Dome which indicates the agreement between the subsurface structure of the dome and the isothermal surfaces.

At Blue Ridge Dome, Fort Bend County, a similar relationship was established, as the flanks of the dome were considerably cooler than the same depths at the top.

The Long Point Dome, Fort Bend County, presented a third example of the temperature-structure relation. It is significant that this dome had not produced oil or gas from the more than fifty test wells drilled up to 1930 on the dome and adjacent areas. The relation between the isothermal surfaces and the structure of the dome is essentially the same as those described at Humble and Blue Ridge, both of which were producing oil and gas.

In the Big Lake field, no relation between temperature and structure was in evidence in the shallow beds but it was apparent at a depth of approximately 2350 feet. Water was absent in the near-surface strata and the deeper beds are water-bearing.

The explanation of this phenomena, as indicated by Hawtof, suggests that a subsurface stratum of water appears to have the same temperature over a given area when level. If a structural uplift raises the water stratum to a higher level in any local area, an increase of temperature per foot of

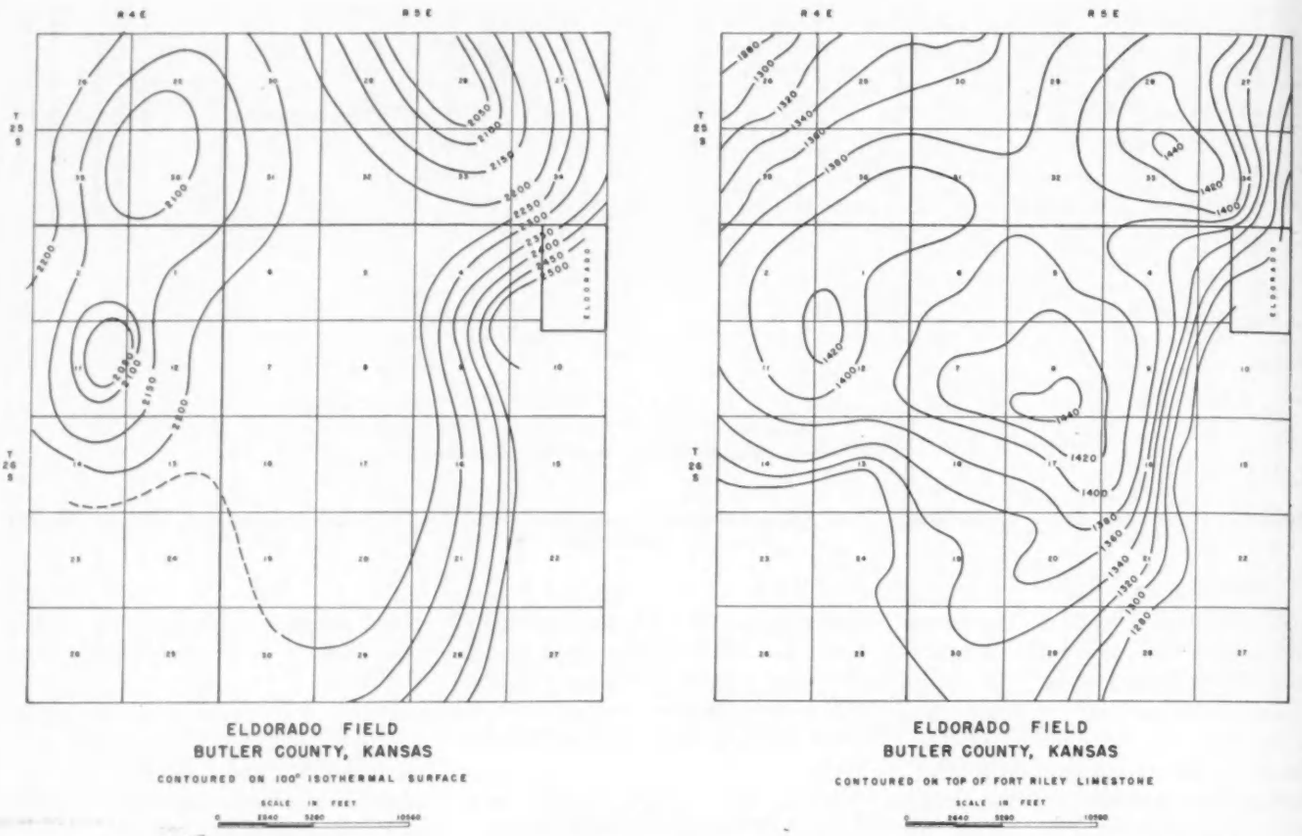

FIGURE 4—Relation between geologic structure and earth temperatures in the El Dorado field, Butler County, Kansas. After McCutchin, API Production Bulletin 205.

depth results and accordingly, the higher temperatures occur over the maximum structural elevations. Hawtof, therefore, expresses the belief that the relationship between temperature and structure may be due to the circulation of thermal waters, for where no circulating waters were present in the near-surface beds, the coincidence between temperature and structure was not observed.

McCutchin's conclusions based on his investigations in Oklahoma are in agreement with this concept of Hawtof's. McCutchin states that the structures which have been the most productive of fluids, either oil or water, show the largest and most uniform variations in temperatures at given depths. McCutchin offers the possibility, therefore, that the removal of large quantities of oil and water from the higher points of the structure has allowed the warmer fluid from greater depths to rise and occupy the pore spaces of the cooler strata. He states that the abnormally high temperatures which were observed in the beds over anticlines may be due to this circulation.

The investigations at the Long Point Dome which was not productive of oil or water at the time that temperature measurements were made, appear to refute both of the above concepts.

• Investigations of Temperature in California

Geothermal conditions in the oil producing areas of California were investigated by Anders J. Carlson.

In California, it was considered that both geological conditions and the distribution of the fields were not favorable for the study of regional temperature-structure relations. The investigations were therefore confined to the determination of temperatures on local structures.

The temperature surveys were concentrated in the Santa Fe Springs and Long Beach fields of the Los Angeles Basin, although a few temperature measurements were taken in other fields. The results were particularly significant only in respect to local anticlinal structure.

At Santa Fe Springs, Los Angeles County, the depth-temperature relations were found to be irregular. Carlson suggests that these irregularities could be explained by the conditions produced artifically in the field, such as new wells and that others appeared to be the result of the character of the rock formations in the field. He states that circulating waters governed the shallow temperatures in the field and found that the isothermal surface at 100° F. showed a partial agreement with the subsurface structure.

Carlson's investigations at Long Beach, Los Angeles County, indicated that the depth-temperature relations were more regular than at Santa Fe Springs and that the 100° F. isothermal elevations defined a surface which was similar to the subsurface contours on top of the producing horizon at approximately 3400 feet.

Carlson concludes that the results encountered in California were considered to support the theory that geothermal gradients will, under some conditions, reflect geologic structure.

• Investigations of Temperature in Kansas

Investigations in Kansas were made by J. A. McCutchin and were confined to the study of conditions associated with local structures.

Studies of the El Dorado field of Butler County indicated that temperature variations were in marked agreement with the geologic structure. In this field, the geothermal maximums were found slightly west of the structural highs. McCutchin states that the highest temperatures were associated with the most prolific producing areas.

Figure 4 shows the temperature-structure relations as determined by McCutchin in the El Dorado field.

Several wells were tested in the Haverhill field, seven miles south of El Dorado. These yielded some interesting temperature information. The wells were located on and adjacent to a producing sand lens. The depth of the 100° F. isothermal surface in two wells which were producing was found to be approximately 100 feet higher than that found in the dry hole. It should be noted that accurate temperature measurements cannot be obtained in producing wells. The tests in this instance, however, were made when the casing was being cemented and although the wells had been shut down for only two or three days, they were found to be in temperature equilibrium.

• Conditions Under Which Temperature Measurements Were Made

The temperature measurements made in Project No. 25 were materially handicapped by the following factors:

• There were long distances between headquarters of the personnel and the wells which were available for measurements, particularly in Texas.

• The small number of wells which in every case were susceptible to temperature investigations. Dry holes are generally plugged a short time after completion. Producing wells and drilling wells, although available, required that the wells be shut down in order to effect a state of temperature equilibrium in the wells. This involved the item of time and the associated expense of the necessary shut-down.

• The inaccuracies in measurements in wells being drilled with rotary tools compared to the results in wells which have stood for a considerable time without drilling in progress and which are, therefore, in temperature equilibrium.

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[2] "Earth Temperatures in Oil Fields"—American Petroleum Institute—Production Bull. No. 205, October, 1930.

(To Be Continued)

Marine Prospecting

Continued from Page 122

providing a cross section of the ocean floor sediments. Correlation between individual cores and detailed study of sedimentary facies can be accomplished. This procedure permits an understanding of past sedimentary processes. Where detailed coring is conducted, it is possible to correlate horizons from core to core and thus establish recent fault patterns.

Where a cross section of sea floor sediments is not in order, other sampling devices are used. For example, a grab type device, which is actuated by strings or weights, will scour the bottom for sediments. Although the technique does not permit development of detailed stratigraphy, it is possible to detect facies changes on the sea floor.

Various dredge designs are often used to retrieve sea floor samples atop rock outcrops. Box shaped or circular design, these dredges are operated from a moving ship which causes the device to recover sea floor samples and often break up rock sediments from outcrops. A classical example was a piece of hard Cretaceous limestone removed from the side of the Hudson submarine canyon at a depth of 3000 feet.

Skin divers are put to work in shallow waters. By this method, a close examination of the sea floor is possible and interesting samples can be delivered to the surface tender. At the same time, the skin divers can map submarine outcrops much in the same manner as the job would be done on land.

It has been proven practical to combine geophysical surveys with studies of sea floor sediments. One reason for doing this is that the accuracy of geophysical interpretation may be greatly affected by varying sediments on the sea floor. False highs in the subsurface interpretation of reflection seismic surveys may be caused by the presence of shell banks or reefs which show a high velocity of propagation of seismic waves. Conversely, false lows may be caused by the presence of depressions in the sea floor filled with highly unconsolidated recent sediments showing low velocity. In either case a correction may be applied if the seismologist knows the nature of the sea floor sediments.

Examples of coordination of oceanography with geophysical studies are found in surveys which have been carried on in some of the following places:

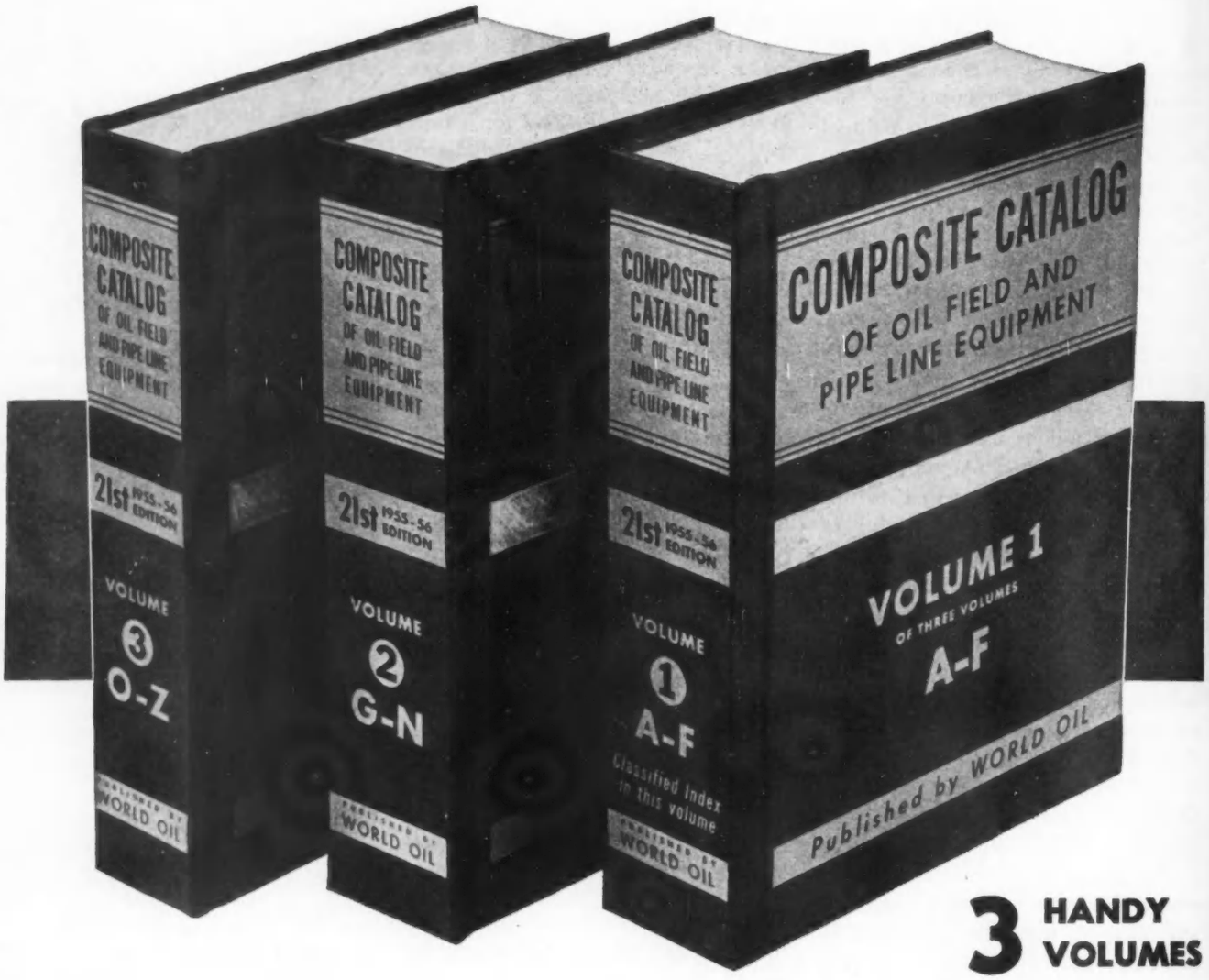
A. Persian Gulf—Coring of sea floor sediments and examination of submarine outcrops by divers was done in conjunction with a gravity survey.

B. Gulf of Mexico. Several major oil companies have combined core sampling of the sea floor with geophysical surveys. This not only aided in interpretation of the geophysical data, but has also enabled the staff geologist to study the sedimentation processes and the micro fossils of the region being surveyed.

C. Gulf of Paria. A detailed study of the recent sediments of this gulf was made by Dutch geologists and oceanographers. This study not only aided in the understanding of facies in the adjacent petroliferous areas of Venezuela and Trinidad, but also furnished much information valuable to the petroleum geophysicist exploring the area.

EDITOR'S NOTE

In the December issue of World Oil, Dr. Goedicke will present a further review of the new exploration tools so essential to speedy, economical offshore oil finding. Here, the author will describe the most recent, revolutionary equipment and technique being regimented for an all out exploratory attack on the problem: Just what underwater reserves exist?



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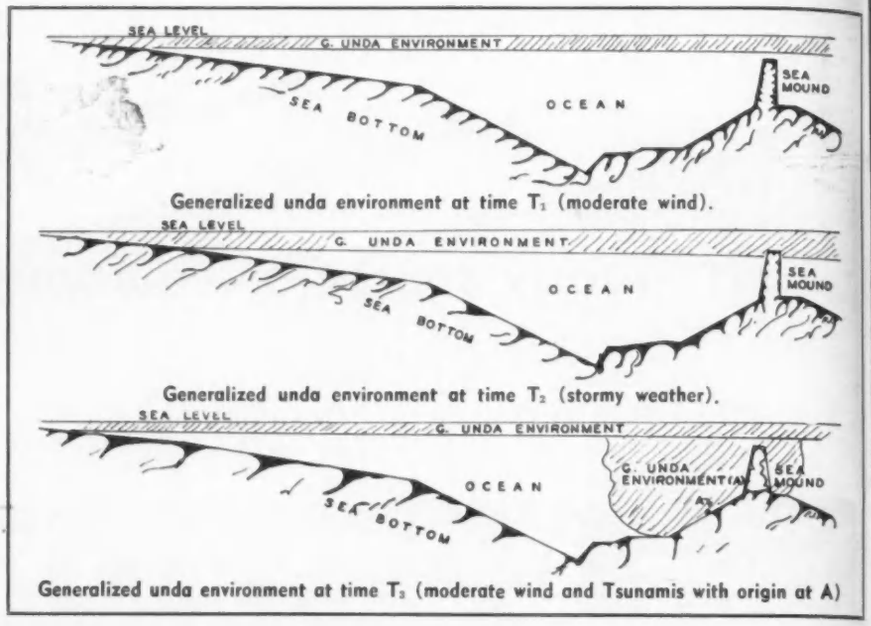

Generalized Unda Environment In Time and Space

By V. G. GABRIEL
Consulting Geologist with Julius Fohs, Houston

UNTIL QUITE recently the speculations on laws governing underwater sedimentation and erosion in relatively deep oceanic waters have been of doubtful scientific value. The reason for it has been the absence of a broad spectrum of scientific observations and some generalized picture or principle related to the processes of underwater sedimentation and erosion. During the last few years, however, the Lamont Geological Observatory, the Woods Hole Oceanographic Institution, the Scripps Institution of Oceanography, and other organizations and scientific investigators have been collecting a great wealth of systematic observations over the oceans of the earth. Quite recently Dr. John Rich published a generalized picture of the underwater environments.

Unda (Wave) Environment—

Rich breaks up the underwater environments into the following groups: unda, clino, and fondo environments. In regard to the unda (wave) environment Rich states: "Wave base, the greatest depth to which the bottom is stirred by waves during storms, is a critical factor . . . Rocks deposited in the unda environment are relatively coarse. The bedding is distinct and commonly has a characteristic waviness. Ripple marks, cross-bedding, flow-and-plunge structure, and lenticularity are characteristic. The unda zone lies entirely in depths through which light penetrates . . ."

The above statements indicate that according to Rich the penetration of light and the wave stirring of the bottom are the principal factors in the recognizing of an unda environment.

Generalized Unda Environment—

The study of the underwater environments shows that many other factors besides wind action produce the stirring of the bottom. Moreover certain wave action and wave phenomena take place at depths far below the zone through which light penetrates. This generalized unda zone is subject to wave action due to various causes such as tsunamis, internal waves, etc.

Tsunamis—

It is accepted that tsunamis are the oceanic waves due to the earthquakes located in the oceanic areas. Although the recorded number of these earthquakes, landslides, etc., is relatively small and their duration is very short, their ability in carrying and depositing sediments at great depths may be large.

Internal Waves—

Theoretical considerations and experimental observations have shown the presence of considerable wave action along the boundary plane separating two liquid layers of different densities. Because of uneven vertical

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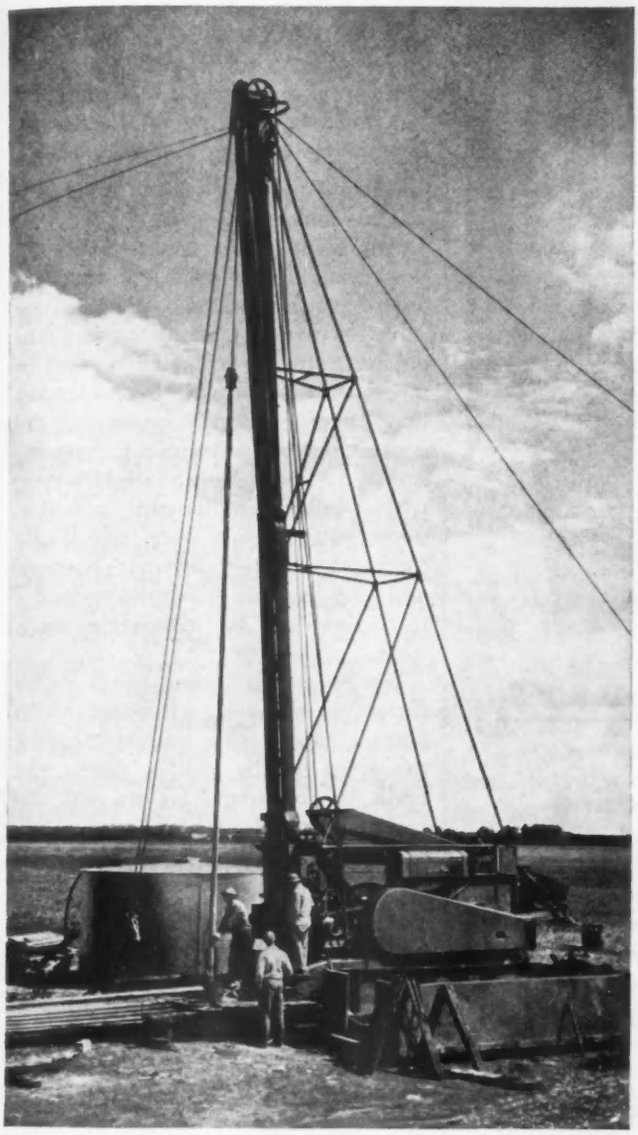

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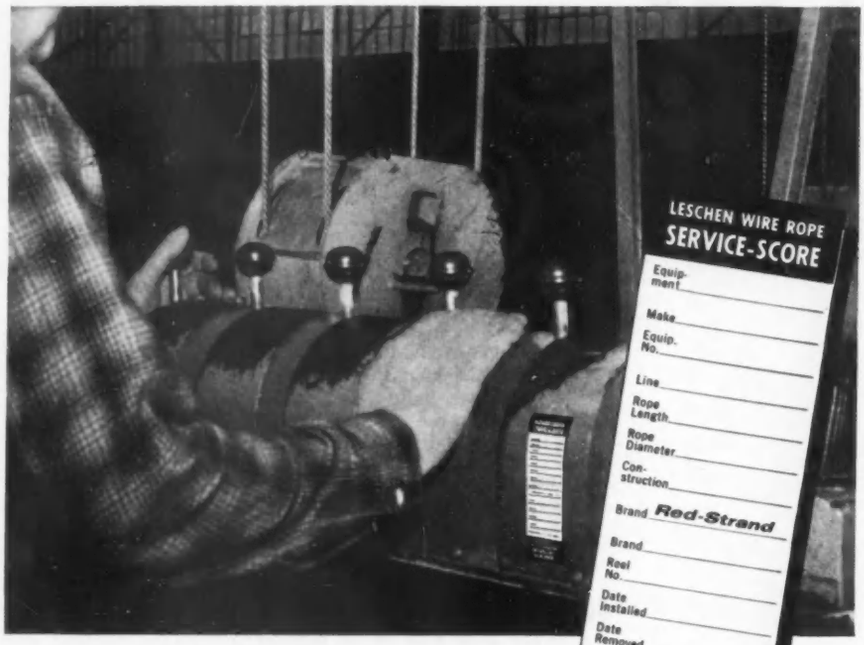

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distribution of temperature and salinity in the oceans, there are numerous boundary planes, separating two liquids of different densities, which exist in many underwater areas of the oceans. A motion started near any boundary plane will be propagated as a wave along the plane acting as an agent of deposition and erosion over the underwater topography touching, figuratively speaking, the boundary plane.

Generalized Unda Zone in Time and Space—

Any point located at the bottom of the oceans at the relatively considerable depth is usually passing in time through certain cycle of underwater environments. When wind is weak or moderately strong, the wave action may never reach the point and the oceanic bottom surrounding the point is outside of the unda zone. However, when wind is exceptionally strong the unda environment may engulf the somewhat deeper oceanic horizons and the oceanic topography under discussion will be within the unda zone.

Under the influence of tsunamis certain portions of the under ocean bottom topography, even located at the great depths, will be within the unda environment. In general the unda environment of any sizable body of water is not a fixed zone but is a mobile one changing in time and space. In time of an exceptionally strong wind and in the oceanic territories where the earthquakes take place of the wave motion, especially those due to tsunamis, it may reach relatively great depths.

Summary and Conclusions—

A generalized unda environment may be considered as a mobile zone in time and space usually located in a relatively large body of water.

In certain oceanic areas a generalized unda environment may reach great depths and the sediments characteristic of the unda environment may be interspaced between the thick beds typical of the fondo and clino environments.

ACKNOWLEDGMENT

The author would like to express his thanks to Dr. D. B. Ericson of the Lamont Geological Observatory and Dr. A. C. Vine of the Woods Hole Institution of Oceanography for helpful information, and Dr. A. C. Spreng of the Missouri School of Mines and Metallurgy, Univ. of Mo., for his helpful suggestions.

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New Welding Technique Cuts Failures on Tubular Goods

Multipass welding and use of low hydrogen electrode recommended for welding medium carbon steels without pre- or postheating.

By J. R. GREGATH, Drilling Engineer,
Helmerich & Payne, Inc.
Tulsa

A NEW TECHNIQUE for producing better welds on oil field tubular goods has recently been developed and preliminary testing completed. This new technique of using a low hydrogen rod and a multipass method of bead application together with good welding practice and better weld joint design is intended to decrease the possibility of weld failure on difficult-to-weld casing steels.

The development of the method followed an extensive study by a major oil company which included the collection of data on the frequency and consequence of weld failure; an analysis of the cause of the weld failure and a preliminary testing program to evaluate the multipass-low hydrogen rod technique. The study of field welding problems was prompted by the realization that welds attaching casing centralizers were in some cases ineffective and that the steel casing beneath these welds could be severely damaged by the weld.

The method was developed primarily for the attachment of centralizers and scratchers but may also be applied to other problems in field welding on oil field tubular goods.

The multipass method of bead application is not appreciably more difficult to apply than one pass welding and the low hydrogen rod costs only slightly more than the rod usually used in the field. This means that the multipass-low hydrogen technique is economical especially when results are considered.

The incident which first brought the problem to the attention of the major oil company happened at a Canadian well. A joint of casing being rolled from the second tier to the walk broke in two at a point where a centralizer stop lug had been welded on. A subsequent research laboratory report on investigating this failure stated "It was apparent that normal J-55 steel becomes brittle, and that serious damage can result when this steel is welded at low temperatures. It is possible in the case of steels containing as much carbon (0.40-0.45 percent) as this grade to have a zone of brittle martensite *even when welding at ordinary room temperature* unless proper precautions are employed." The report recommended; to preheat to 300°-500° before welding, reheat to 1100°-1200° F. after welding, and cool slowly.

The recommendation to preheat, postheat, and slow cool welds normally made out in the field under conditions that are hardly ideal was viewed with alarm. It was considered that these heat treating operations would be impractical in the field and uneconomical in a shop. When installing centralizers and scratchers welding was necessary and, at the time of the report, was also the most economical when compared with mechanical stop collars.

With the knowledge that welds attaching centralizers and scratchers could possibly be ineffective in permanently attaching this equipment and that the application of welding could even damage the casing steel beneath the weld, the first step was to determine why welds fail.

Cause of Failure. Weld failure can be the result of one or a combination of several factors. A poor quality weld is apt to fail even when made on steels of good welding characteristics. If welds are produced that are cracked, undercut, burned or pitted; contain slag inclusions, gas pockets or cold closure; or are structurally unsound in weld contour, the possibility of weld failure is increased. Examples of weld contour are shown in Figure 1.

Hidden cracks and brittleness beneath the weld can also lead to failure. These cracks become points of "notch effect" stress concentration and rupture when subject to shock or movement. At least three conditions are known to contribute to the development of cracks in the heat-affected zone beneath the weld, as shown in Figures 2 and 3.

1. Hardenability of the steel: This property is a function of the carbon and alloy content of the steel. Most casing steels in API grades J-55, N-80 and P-110 are of sufficient carbon and alloy content to be considered hardenable on welding. Hardenability generally means a lack of weldability.

2. If the cooling rate immediately following the placement of the weld metal is too rapid so that a hard brittle zone is formed. When subject to the thermal cycle of arc welding the cooling rate in the heat-affected zone beneath the weld may be extremely rapid due to the mass quenching action of the surrounding metal.

3. An appreciable amount of hydrogen is taken up from the atmosphere surrounding the arc during welding. In electric welding with welding rods that are coated to give stability to the arc and provide fluxes for slagging off oxide, moisture that is held as water of crystallization in some constituents of the coating, or is merely absorbed in the coating, or the hydrogen in the cellulose of cellulose-coated rods, is available to injure the weld. Hydrogen is increasingly being held responsible for cracks in and around welds. These cracks were previously ascribed wholly to the production of hard zones of martensite or lower bainite resulting from transformation of austenite. Although strict limits have been set by the American Welding Society to hardness in the heat-affected zone, some technicians believe that the mere presence of a thin hard zone, backed up on both sides by softer tougher

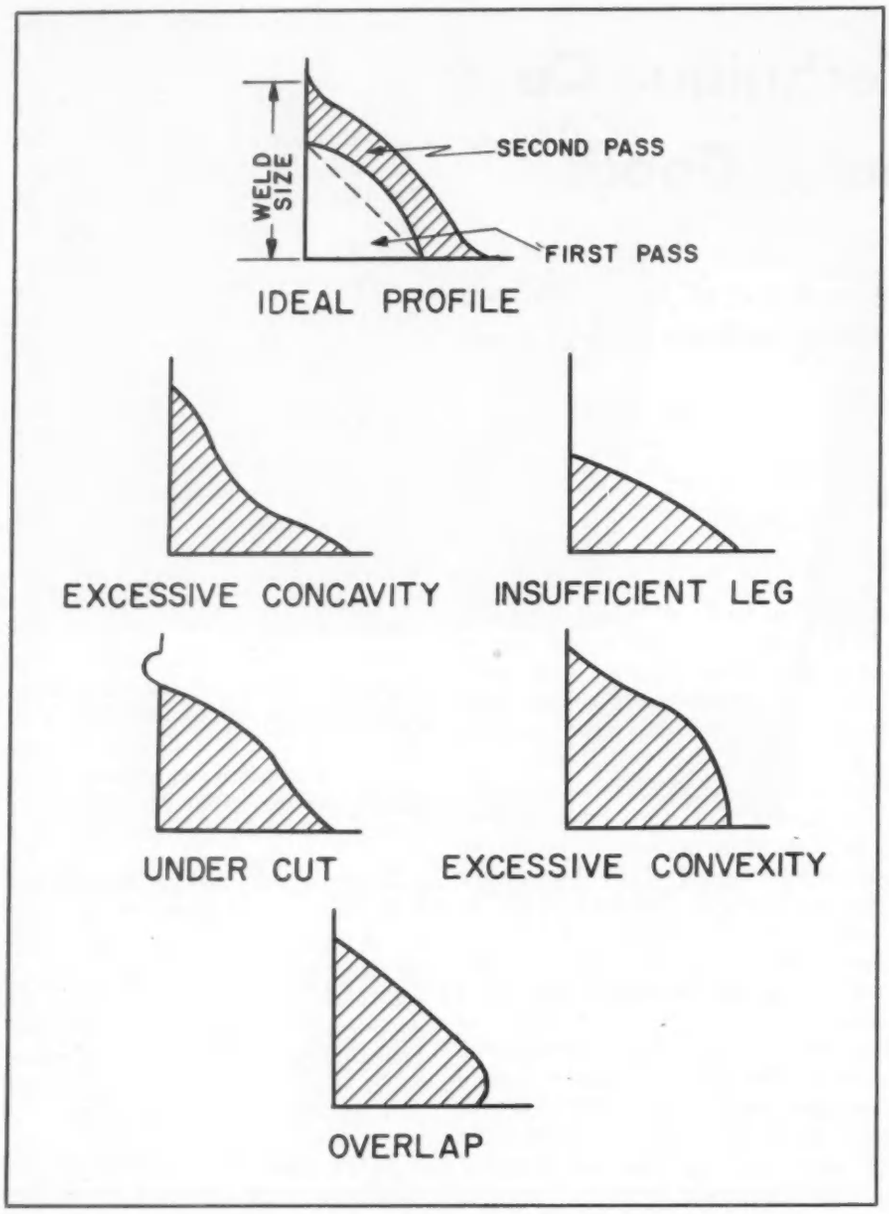


FIGURE 1—Profile defects in fillet welding.

structures, is not necessarily harmful, and that cracking which is harmful can more easily be avoided if hydrogen is not present.

Evidence is accumulating that some types of weld cracking are due to the simultaneous presence of martensite and hydrogen, the hydrogen being responsible for the cracking of the martensite. Avoiding martensite by use of non-hardenable steel, or slowing the cooling rate, or avoiding hydrogen by proper selection of the welding rod coating helps to prevent cracking. The latter expedient opens the way to welding of strong steels previously considered unweldable.

With these three conditions present it is believed that the hard brittle heat-affected zone (Figure 2) is further embrittled or ruptured in some manner by the hydrogen and that cracks are then propagated by restraint and thermal stresses. With usual welding practice on many casing steels, all three conditions (mentioned above) favorable for the production of cracks frequently are satisfied.

Another very important factor to be considered is the human element. The term refers to the quality imparted to a weld by the art of the welder. No matter how technically perfect the rod and welding procedure are fitted to the job; welds, that due either to the welder's attitude or inexperience are cracked, undercut, burned or pitted, contain slag inclusion, gas pockets or cold closures, or are structurally unsound in weld contour, are more likely to fail than those without defects.

The technical limitations of welding on the steels used in oil field tubular goods are complex, but fairly well understood. As opposed to the limitations of the human element, the technical limitations of welding usually lead to defects which cannot be seen.

With an understanding of why welds on oil field tubular goods might fail it is also important to know just what weld failure could mean to the operator.

Frequency and Consequence of Failure—In addition to the Canadian incident several other failures have been reported. Welds attaching centralizers and scratchers have fallen off as the casing was being moved on the rack.

It is probable that there are more weld failures and weld damage to oil field tubular goods than is now suspected. In the case of centralizers, scratchers, couplings and floating equipment, the welds are buried in the borehole before they are subjected to any stress. In such cases the consequences of failure of the weld or damage to the casing would probably be attributed to hole conditions or corrosive waters.

Although it is very difficult to prove, it is strongly suspected that welds on couplings and floating equipment may, through damage to the casing steel beneath the weld, actually contribute to, rather than prevent, the loss of the bottom joints

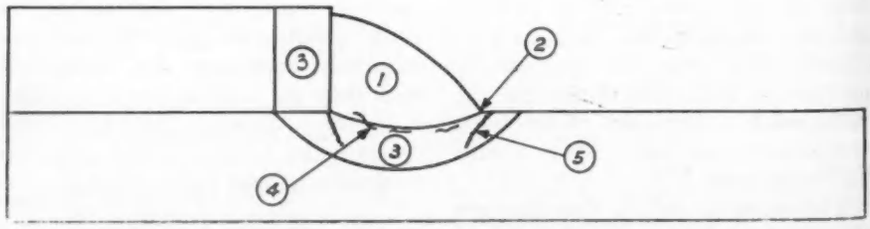


FIGURE 2—Weld and crack nomenclature. 1. weld zone, 2. fusion zone, 3. heat affected zone, 4. underbead cracks, 5. toe cracks.

from casing strings.

Generally, in welding around drilling rigs, and in the yards on substructures, pipe racks, braces, etc., where used drill pipe or casing is being used as structural members, it is a relatively common complaint that welds crack or pull out of the pipe due to the pipe being "old and crystallized."

The consequences of weld failure or weld damage to the steel beneath could be expensive. The loss of centralizers and scratchers could result in stuck pipe with the possible abandonment of a well. It could cause a poor cement job if the casing got to bottom; and junk in the hole if the casing were recovered.

On floating equipment and couplings, cracks in or beneath the weld would certainly assist, rather than prevent a bottom joint or joints being either backed off or knocked off. More generally, the failure of welds around a drilling rig means that the welds have to be made over and, in the absence of applied design, more bracing is usually added at additional time and expense.

The New Technique. Since it is unlikely that casing steel chemistry will change to yield more weldable steel, the approach to the problem lies in controlling the cooling rate and eliminating hydrogen.

The welding industry has long been concerned with the difficulties of welding on medium carbon steels such as casing and has made recent advancement in both electrode selection and application that are specifically designed to produce satisfactory welds on medium carbon steels without preheating or postheating.

The electrode development is known as a "low hydrogen" type. As the name implies it was designed to limit the amount of hydrogen surrounding the atmosphere of the arc. The electrode coating of the low hydrogen rod is designed to provide an atmosphere of carbon dioxide around the arc. This limits the possibility of absorption of hydrogen by the parent metal beneath the weld which in turn reduces the possibility of weld failure due to hydrogen embrittlement or rupturing.

The application technique suggested is referred to as a "multipass" technique. Multipass actually refers to "more than one" and, if properly applied, is intended to both slow the cooling rate and stress relieve the metal beneath the weld. The multipass technique is actually intended to be a substitute for preheating and postheating and as previously discussed in "Cause of Failure" if the cooling rate can be controlled so that there will be no mass quenching of the weld metal and steel beneath, then a better weld will result. In multipass welding either two or three passes with a $\frac{1}{8}$-inch or $\frac{5}{32}$-inch rod, short runs, (3 to 6 inches) and low penetration are used. As each pass is laid on, it is cleaned immediately and the next pass applied.

FIGURE 3—Field weld on horseshoe lug at 40x magnification. This is an example of underbead cracking.

The multipass technique actually is the application of known welding principles. Although, as far as is known, the practice of using a multipass technique or even the low hydrogen rod is not common to field welding on oil field tubular goods. In most field applications, single-pass or two-pass welding in which no attempt is made to control the cooling rate is done with an AWS E6010 electrode. The E6010 rod, which incidentally is not designed for welding medium carbon steels such as casing, is extremely popular. Most E6010 rods have a cellulosic coating which is a source of hydrogen.

Technique Evaluated. Having decided to evaluate the multipass-low hydrogen rod technique the company involved embarked on an extensive series of field and laboratory tests. As a basis for comparison, a shoe joint of N-80 casing with two centralizers and seven scratchers attached was taken from the rack at a drilling well and samples of these typical field welds were made available for analysis. The field welder on this job had a good reputation in his area and did not know that the welds were to be examined. Multipass welds were then made on the same piece of casing; with the pipe at room temperature for one series of welds, and precooled to —25° F. to provide more severe conditions for another series of welds. Both multipass and field welds were then analyzed with metallograph and physical tests at a local testing laboratory.

Although space does not permit a complete discussion of the results of the testing program it was found that:

- The field welds were very poor in surface quality and contour.
- Although there was some martensite beneath the laboratory welds, the micro-structure was relatively more favorable than that beneath the field welds.
- Welds on attachments of different shape produced different effects on the casing. Further study in this field revealed that some of the attachments are not well designed for welding. This applied particularly to couplings and floating equipment. Due to the design of the coupling, a gap, commonly referred to as the collar recess, exists between the collar and the casing and cannot be filled with weld metal. This gap then holds carbonaceous material and becomes a

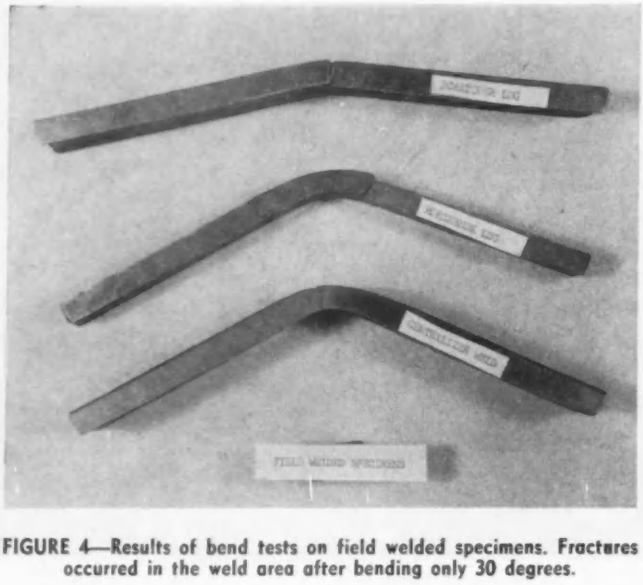


FIGURE 4—Results of bend tests on field welded specimens. Fractures occurred in the weld area after bending only 30 degrees.

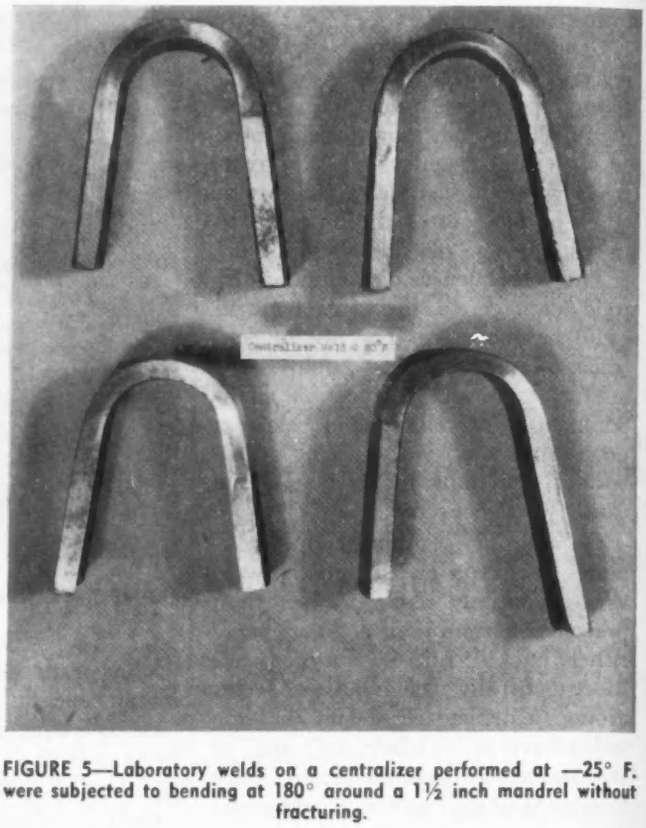


FIGURE 5—Laboratory welds on a centralizer performed at —25° F. were subjected to bending at 180° around a 1½ inch mandrel without fracturing.

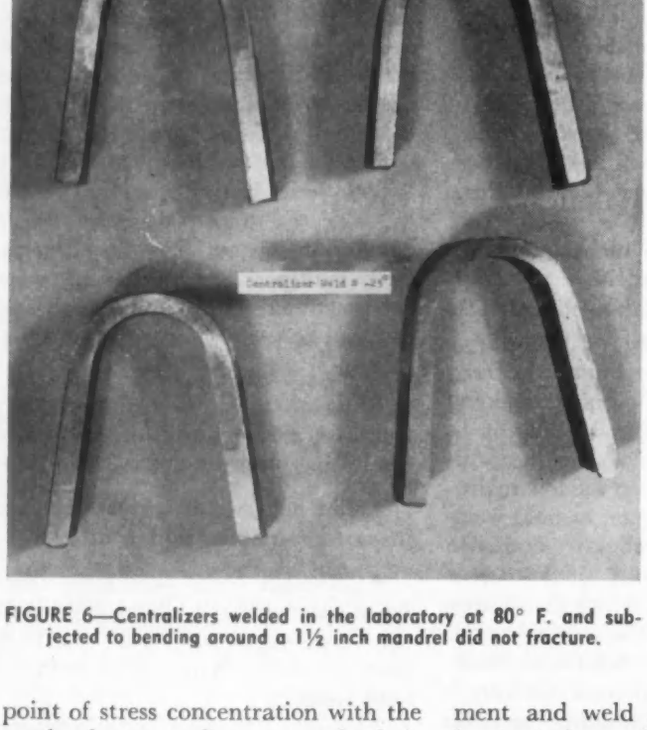


FIGURE 6—Centralizers welded in the laboratory at 80° F. and subjected to bending around a 1½ inch mandrel did not fracture.

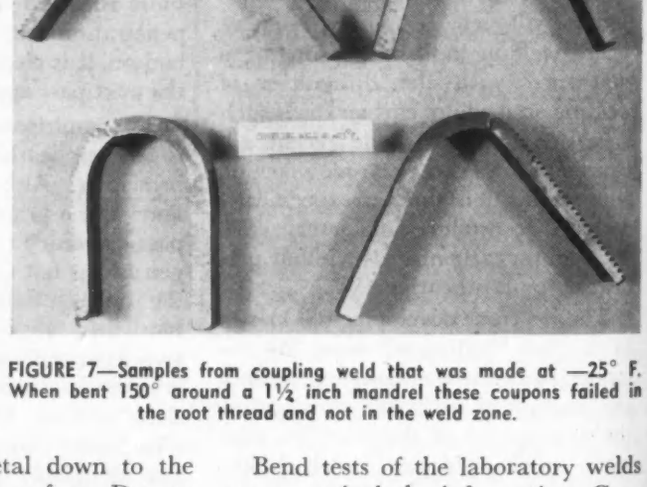


FIGURE 7—Samples from coupling weld that was made at —25° F. When bent 150° around a 1½ inch mandrel these coupons failed in the root thread and not in the weld zone.

point of stress concentration with the result that any flexure or shock is likely to crack the weld.

- The hardness tests were inconclusive.
- The bend tests seemed the most informative.

Figure 4 illustrates bend tests of field-welded samples which caused the coupons to fracture in all cases in the weld area after bending approximately 30 degrees. The coupons were prepared by removing the attachment and weld metal down to the level of the casing surface. Due to the poor weld quality there were still some slight pits beneath this level. It cannot be absolutely determined whether the field-welded bend test samples fractured due to the surface defects or due to underbead cracking coupled with brittleness. Subsequent investigation based on this point revealed that there was a greater degree of underbead cracking beneath the field welds than beneath the laboratory welds.

Bend tests of the laboratory welds were particularly informative. Coupons from centralizer welds made at both —25° F. and 80° F. were bent 180 degrees around a 1½-inch mandrel without fracturing. Coupons from the coupling weld which was made at —25° F. bent 150 degrees around a 1½-inch mandrel and fractured in a thread root with no evidence of failure in the weld zone. These bends are shown in Figures 4, 6 and 7. The bend test seems adequate for determining whether or not

a weld is acceptable. It is realized that the laboratory welds produced with a multipass technique and a low hydrogen type rod are not technically perfect. The competence exhibited by these welds when subjected to the bend tests has led to the belief that properly made welds using this technique and low hydrogen rod would be more than adequate for attaching centralizers and scratchers.

From the results of the testing program it was concluded that weld failure was not just a cold weather problem but could be expected in Mid-Continent operations. Weld failure can be due as much to poor welding practice as to changes in grain structure due to weld application.

It was also concluded that the advisability of welding couplings and floating equipment deserves further study. Manufacturers of cementing accessories that are attached by welding should review their equipment design with an eye toward better weld joint design.

It was recommended that welding be continued as a method of attaching centralizers and scratchers and that this welding follow the procedure outlined below.

Recommended Procedure. This procedure is intended to serve as a guide to field personnel in obtaining satisfactory welds on oil field tubular goods, and to provide some background so that the problem could be reasonably discussed with the welder. It is not intended as instruction in the art of welding, nor is it an attempt to provide a manual on welding inspection.

Material and Method—The electrode recommended for use on oil field tubular goods is either an AWS E6016 or AWS E7016 rod. Both are nominally called "low hydrogen" type rods. The low hydrogen electrode is designed to provide an atmosphere of carbon dioxide around the arc, thereby limiting the possibility of absorption of hydrogen by the casing steel beneath the weld, which in turn reduces the possibility of underbead cracking due to hydrogen embrittlement or rupturing. Since the low hydrogen rods are relatively new, welders should be encouraged to experiment with the rods on scraps of N-80 casing or Grade E drill pipe.

The technique recommended is a multipass method in which a small diameter rod is used for short runs with low penetration for either two or three passes. Each successive pass is laid on very quickly after cleaning the preceding bead. The purpose of the quick application of the second, or second and third passes, is to prevent the metal heated by the previous pass from cooling quickly enough to become brittle. Each succeeding pass also tends to stress relieve the heat-affected zone beneath the previous pass.

Even with the best rod and technique for welding on medium carbon steels, the finished weld can be ruined by sloppy welding practice. It should be emphasized that in attaching casing centralizers and scratchers a quality weld is required. The welds should not be pitted, cracked, burned or undercut; contain slag inclusions, gas pockets or cold closure, or be unsound in weld contour.

It is recognized that good welds have been produced in the field and could possibly continue to be produced with conventional techniques. However, due to the variations in casing steel chemistry and welder attitude, the possibility exists that conventional methods will yield, in a significant percentage of cases, ineffective welds. This procedure, low hydrogen rod-multipass technique, attempts to eliminate both casing steel chemistry and careless welders as causes of weld failure.

Application—This procedure applies to field welding on the following oil field tubular goods:

1. API casing grades F-25, H-40, J-55 and N-80.
2. API tubing grades F-25, H-40, J-55 and N-80.
3. API drill pipe grades C, D, and E.
4. API line pipe grades A, B, and C.

This procedure does not apply to:

1. API tubular grades P-105 or P-110.
2. Drill collars unless the composition is *known* to be similar to a weldable steel.
3. Any casing, tubing or drill pipe not covered in applications 1 through 3 above unless the chemical composition is *known* to be similar to a weldable steel or unless samples of the material have been fillet welded, without preheating or postheating, and the soundness of the weld checked by bending. A satisfactory bend test could be made in a vise.

Procedure for Welding in Attaching Casing Centralizers and Scratchers:

1. The area to be welded should be brushed or wiped free of any excess paint, grease, scale or dirt.
2. The attachment should fit as closely as possible to the casing surface.
3. In scratcher lug attachment, care should be taken that all lugs are in line.
4. Care should be taken that the joint is properly grounded. Bad contact may cause sparking which could result in spots of hardness with cracks beneath.
5. A "low hydrogen" type electrode, either AWS E6016 or AWS E7016 should be used. The rod should be either ⅛-inch or 5/32-inch in diameter. Low hydrogen rods have a thicker coating than ordinary rods and require the operator to hold a shorter arc than usual. With the thicker coating, it is also more difficult to start the arc and to avoid pitting the casing where the arc is struck.
6. A multipass method of bead application should be used. With the low hydrogen rod a small stringer bead is deposited, cleaned immediately and the next pass laid over it. Either two or three passes may be used. Weaving should be kept to a minimum and the current should be on the low side of the range recommended by the rod manufacturer. In order to obtain the maximum stress relieving effect of the multipass technique, each bead should be substantially the same size as the bead which it covers.
7. If welds longer than four to six inches are to be made, backstepping is advantageous. For example: If six inches of weld has been deposited as a stringer bead from left to right and an immediate second pass has been applied, then the operator should start about six inches to the left of the weld deposited and weld up to the starting point of the weld previously deposited and in the same manner.

ACKNOWLEDGMENT

This article is based on an engineering report: "Welding for the Attachment of Centralizers and Scratchers," prepared by the writer while in the employ of Gulf Oil Corporation. It is published through the courtesy of Gulf Oil Corporation in the hope that the information will be of interest and assistance to the oil industry. Figures contained in this article were furnished and are published through courtesy of Gulf Oil Corporation. The writer also wishes to thank the following for their assistance in the investigation: R. L. Looney, Lincoln Electric Company; H. M. Cooley, Bethlehem Steel Company; P. L. Wilson, Halliburton Oil Well Cementing Company; D. I. Grand, Tulsa Testing Laboratory, and E. D. Hall, Weatherford Oil Tool Company.

Usefulness of Dip Information In Drilling 'Crooked' Formations

Dipmeter surveys aid in selection of suitable hole drilling techniques.

By ARTHUR LUBINSKI and K. A. BLENKARN
Stanolind Oil & Gas Company
Tulsa

WHEN DRILLING crooked hole formation, the knowledge of dip, in addition to customary well drilling data, may enable the drilling engineer to make recommendations which should result in a decrease of drilling costs in neighboring wells.

In a West Texas well, exceedingly crooked hole formations were encountered although the dip was only 15 degrees. For such conditions, use of several stabilizers before the deviation builds up and carrying much heavier weights could be recommended. It would have been exceedingly expensive to maintain a small hole deviation if the sound policy of permitting large deviations were not followed.

If, on the other hand, the dip had been 45 degrees, then one and not several stabilizers should be recommended and the use of larger collars and a larger hole size would be advisable. Moreover it would not be prohibitive to maintain the hole at lower deviations.

It is recommended that, if necessary, dipmeter surveys be run in wells in which "crooked" formations were encountered, in order to improve drilling programs in neighboring wells.

Actually Encountered Case of Crookedness With Moderate Dip. Recently the drilling records of a West Texas well were studied. At 11,160 feet the deviation was 4 degrees. Below that depth, the deviation progressively increased, reaching 12½ degrees at 11,660 feet. The deviation was constant between 11,660 and 11,810 feet. Therefore, for that interval the angle of 12½ degrees corresponds to an equilibrium condition. Below 11,810 feet, the deviation progressively decreased.

The drilling conditions in the abovementioned crooked interval could be summarized as follows:

Hole gage	7⅞ inches
Drill collars	6⅝ inches
Stabilizers	None
Weight	30,000 pounds
Equilibrium hole deviation	12½ degrees
Formation dip	15 degrees

Using the charts of References 2 and 3, we have investigated how the interval under consideration would drill under a great variety of other conditions. The results are shown in Figures 1A, 2A, 3A, and 4A, in which equilibrium hole deviation is plotted versus either the weight or the weight per inch of hole diameter. For reasons given in References 1 and 2, the weight per inch is considered in the cases where situations in holes of various sizes are compared. Figures 1A, 2A, and 3A are for 6⅝-inch drill collars in 7⅞-inch hole, 8-inch collars in 8¾-inch hole, and 11¼-inch collars in 12¼-inch hole respectively. In each of these figures, curves for collars without any stabilizer and with a stabilizer at the optimum position are drawn.

The following conclusions may be drawn from the inspection of the curves:

1. Both the use of one stabilizer prop-

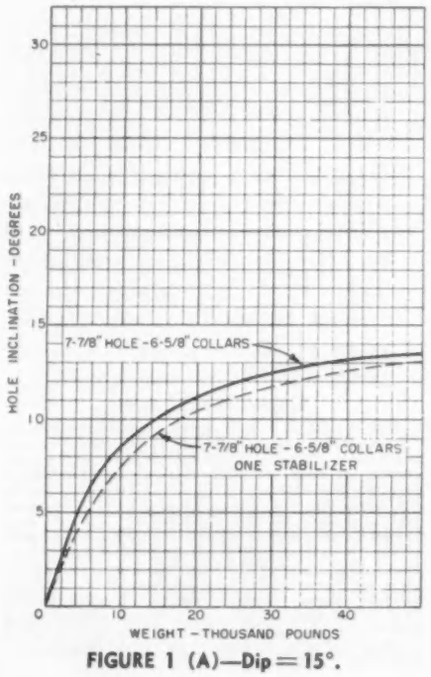


FIGURE 1 (A)—Dip = 15°.

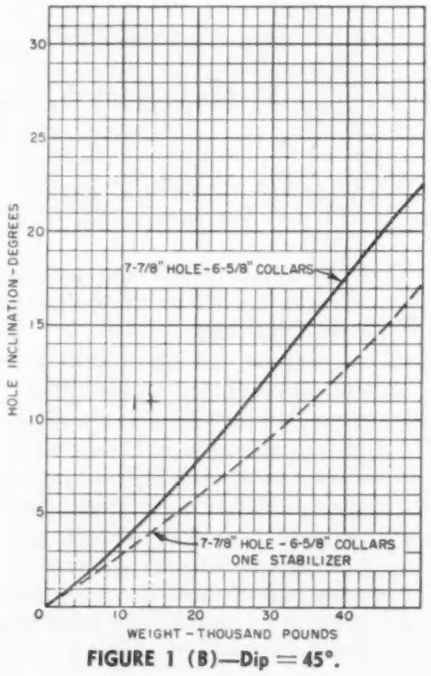
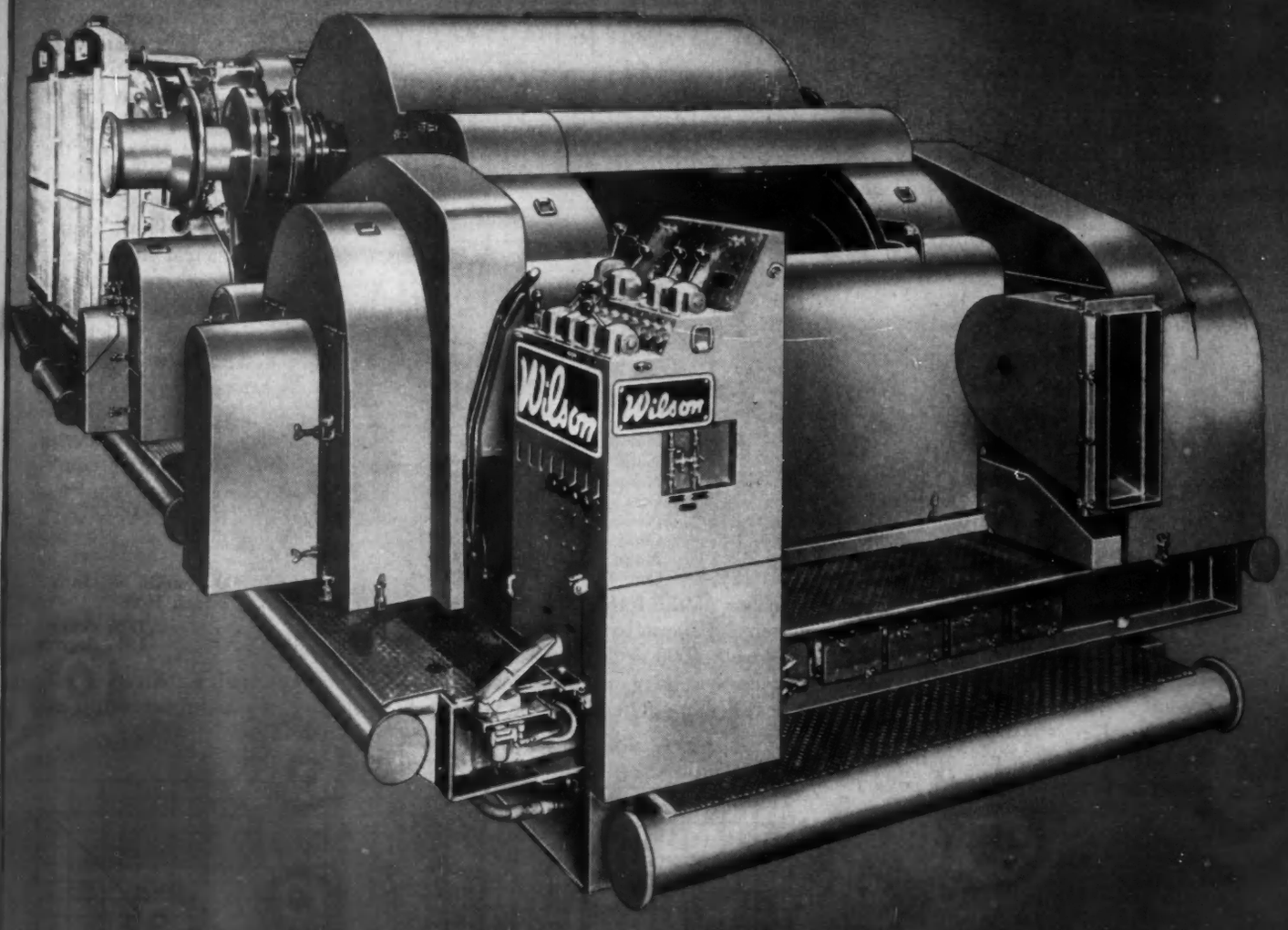


FIGURE 1 (B)—Dip = 45°.

SUPER GIANT RIG



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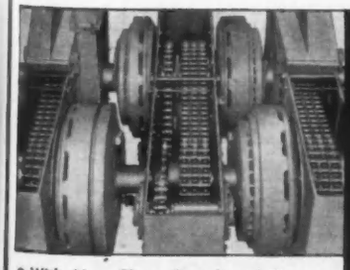

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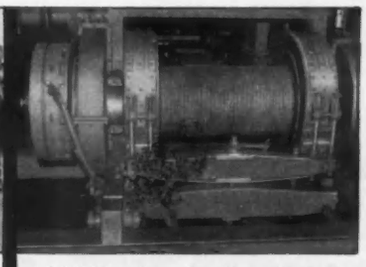

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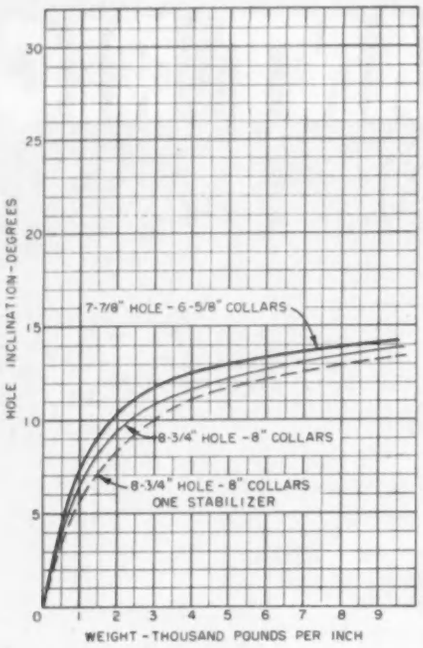
HOLE INCLINATION - DEGREES
7-7/8" HOLE - 6-5/8" COLLARS
8-3/4" HOLE - 8" COLLARS
8-3/4" HOLE - 8" COLLARS
ONE STABILIZER
WEIGHT - THOUSAND POUNDS PER INCH

FIGURE 2 (A)—Dip = 15°.

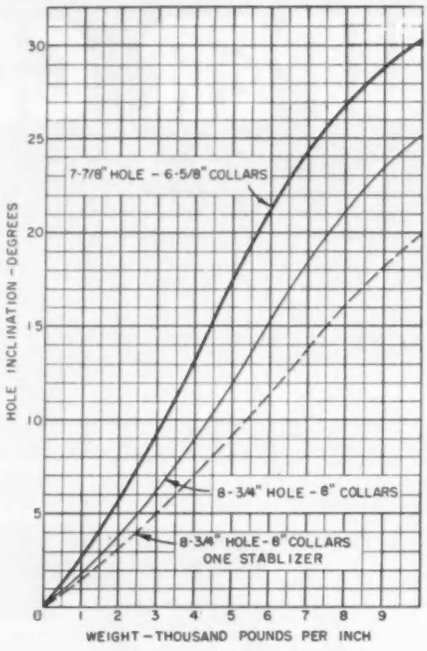
HOLE INCLINATION - DEGREES
7-7/8" HOLE - 6-5/8" COLLARS
8-3/4" HOLE - 8" COLLARS
8-3/4" HOLE - 8" COLLARS
ONE STABLIZER
WEIGHT - THOUSAND POUNDS PER INCH

FIGURE 2 (B)—Dip = 45°.

erly located in the string and the use of larger collars permit carrying appreciably more weight without increasing hole deviation.

Examples for 12½-Degree Hole Deviation

Collars	Hole	Stabilizer	Pounds/Inch	Pounds
6⅝	7⅞	None	3810	30,000
6⅝	7⅞	One	4950	39,000
8	8¾	None	5250	46,000
8	8¾	One	6500	57,000
11¼	12¼	None	9300	114,000
11½	12¼	One	11,300	138,000

2. The above conclusion always holds true. In the particular case under consideration, however, the deviation would hardly be increased if the above weights per inch were simply carried with *6⅝-inch collars in 7⅞-inch hole without any stabilizer.*

Examples		
Pounds/Inch	Pounds	Degrees
3810	30,000	12½
5250	41,000	13¼
9300	73,000	14¼

3. Thus, use of larger collars and/or one stabilizer would be advisable only if there is a maximum permissible value of hole deviation. If, on the other hand, appreciable hole deviation approaching the dip angle can be tolerated, then use of larger collars and/or one stabilizer is not warranted.

4. Appreciable decrease of weight results in a very small decrease of deviation.

Example for 6⅝-Inch Collars in 7⅞-Inch Hole Without Any Stabilizer

Pounds	Degrees
30,000	12½
20,000	11¼

5. Exceedingly light weights should be carried to maintain a small deviation.

Examples for 5 Degrees

Collars	Hole	Stabilizer	Pounds/Inch	Pounds
6⅝	7⅞	None	560	4400
6⅝	7⅞	One	700	5500
8	8¾	None	670	6000
8	8¾	One	810	7100
11¼	12¼	None	1200	14,700
11¼	12¼	One	1600	19,600

Because of the hardness of the encountered formations in the West Texas well, 4000 or 5000 pounds per inch were necessary on the bit for economical drilling. Therefore, the above examples show that a 5-degree deviation could have been maintained only by increasing the hole gage to a size which is altogether out of reason. We know of a few cases in which dip information was not available and, therefore, reaching positive conclusions is not possible; however, we think that the formation crookedness and dip were, most likely, similar to those of the case described here. The operators rigidly enforced the contractual clause calling for a 5-degree maximum hole deviation. This resulted in a necessity for setting 5 or 6 whipstocks and subsequent great loss of money to the drilling contractors.

Use of several stabilizers on the lower portion of the string has about the same effect as a decrease of hole size with no stabilizers. Thus, assuming a stabilizer diametral clearance of ⅛ inch, use of several stabilizers on 6⅝-inch collars is equivalent to having a 6¾-inch hole, for which the results, plotted in Figure 4A, are designated as pertaining to several stabilizers.

Figure 4A shows that use of several stabilizers results in a greater equilibrium hole deviation (because of less pendulum effect), but by a very small amount.

Examples for 30,000 Pounds, 6⅝-Inch Collars, 7⅞-Inch Hole

No stabilizers .....12½ degrees
Several stabilizers .....13¼ degrees

Use of several stabilizers could, however, be very useful before the de-

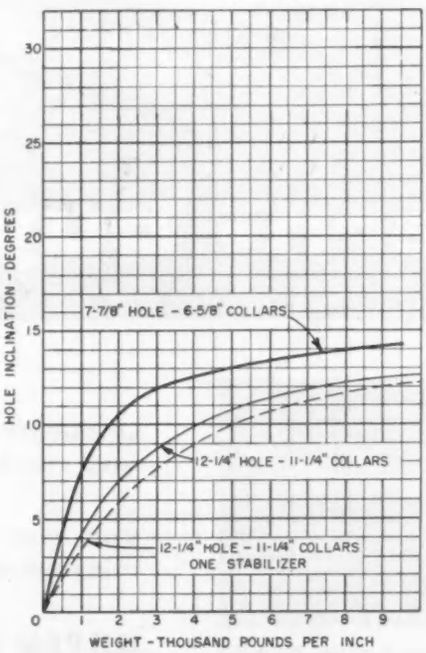
HOLE INCLINATION - DEGREES
7-7/8" HOLE - 6-5/8" COLLARS
12-1/4" HOLE - 11-1/4" COLLARS
12-1/4" HOLE - 11-1/4" COLLARS
ONE STABILIZER
WEIGHT - THOUSAND POUNDS PER INCH

FIGURE 3 (A)—Dip = 15°.

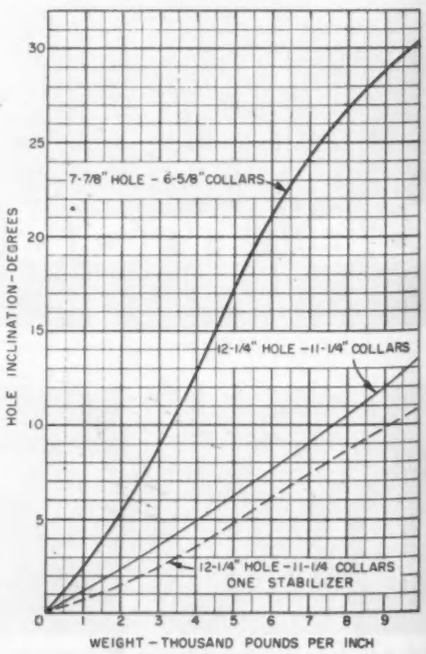
HOLE INCLINATION - DEGREES
7-7/8" HOLE - 6-5/8" COLLARS
12-1/4" HOLE - 11-1/4" COLLARS
12-1/4" HOLE - 11-1/4 COLLARS
ONE STABILIZER
WEIGHT - THOUSAND POUNDS PER INCH

FIGURE 3 (B)—Dip = 45°.

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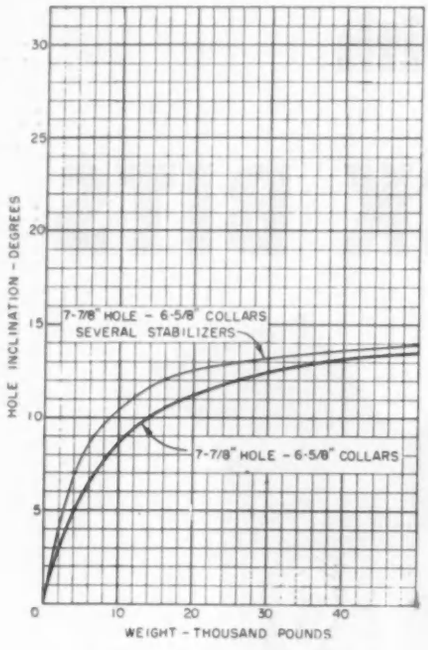

FIGURE 4 (A)—Dip = 15°.

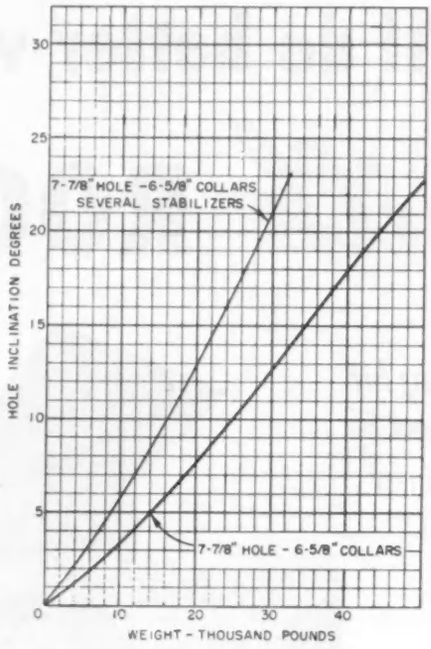

FIGURE 4 (B)—Dip = 45°.

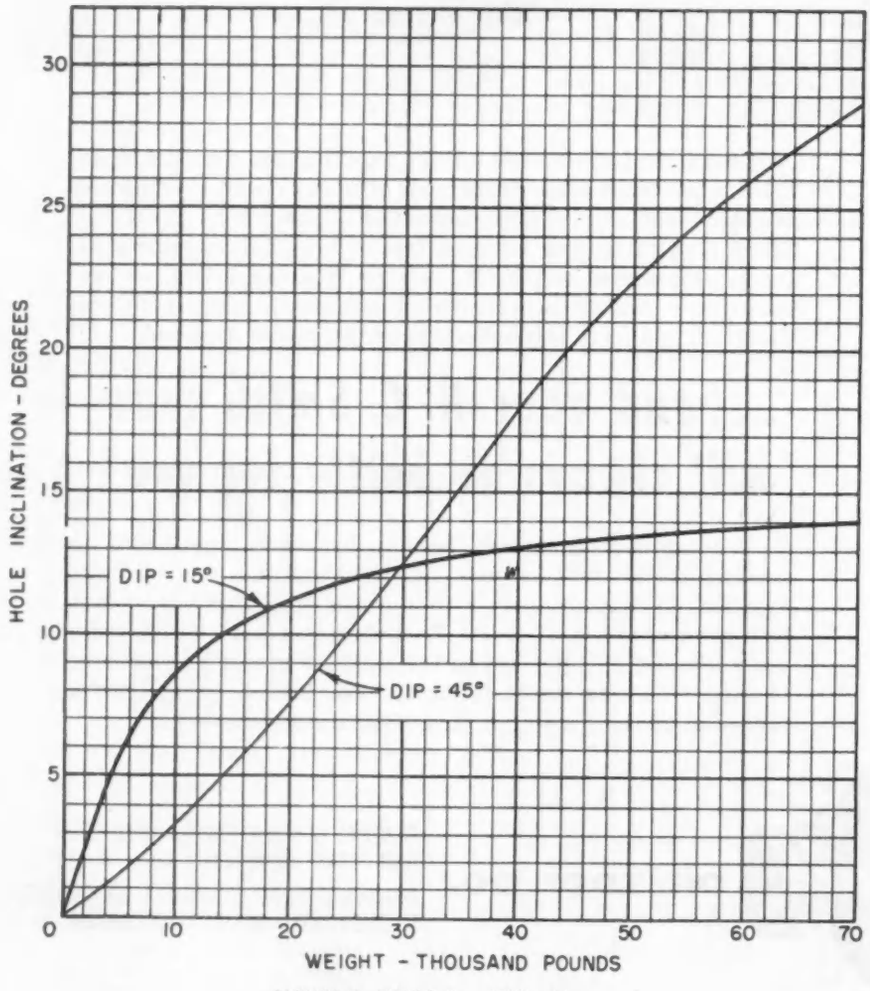

FIGURE 5—7⅞" hole—6⅝" collars.

viation builds up, insofar as it would have greatly decreased the rate of angle buildup. In the 650-foot crooked interval under consideration (11,160 to 11,810 feet), the equilibrium angle would probably not have been reached. Therefore, use of several stabilizers could have been useful if it had been desired to reduce the maximum deviation to perhaps 8 or 10 degrees instead of 12½ degrees. By several stabilizers on the lower portion of the string we mean an assembly comprising, for instance, a dull reamer above the bit and stabilizers at 15 and 30 feet above the bit.

The knowledge of dip (15 degrees) was necessary for preparing all the figures already mentioned. However, Conclusion 1 above holds true regardless of dip value. The numerical examples which followed that conclusion could have been written without the knowledge of the dip by using a chart of Reference 2.

On the other hand, none of the other above conclusions or statements could have been reached or made without the knowledge of formation dip. It is therefore recommended that, whenever needed for drilling purposes, dip information be secured either from geological data or from dipmeter surveys. The cost of a dipmeter survey should be negligible with respect to the saving in drilling costs. The attention of the reader is focused toward continuous dipmeter surveys, now available from service companies, which give much more reliable results than conventional surveys.

Hypothetical Case of Crookedness With Large Dip. Assume, for instance, the same drilling conditions as mentioned at the beginning of this paper, but a formation dip of 45 degrees instead of 15 degrees. The formation would still be very crooked, because a weight of 30,000 pounds with 6⅝-inch collars would result in a deviation of 12½-degrees. But the nature of "crookedness" would be different. With a 15-degree dip, the "crookedness" is mainly due to such factors as frequent alternations with sharp contrasts between hard and soft streaks. These factors designated as "high anisotropy index" in References 1 an 2. With a 45-degree dip, it is mainly due to the high value of the dip itself. This results in an essentially different shape of deviation versus

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weight curves. The difference is best seen in Figure 5, in which two curves are drawn for the cases of 15- and 45-degree dips respectively. In addition, for the 45-degree dip case, Figures 1B, 2B, 3B, and 4B were prepared, which correspond to Figures 1A, 2A, 3A, and 4A respectively.

The following conclusion may be drawn from the inspection of the curves:

1. Conclusion 1 previously reached still holds true, word by word, including the examples. This is in agreement with the previous statement that this conclusion is independent of the formation dip. Thus, either use of one stabilizer properly located in the string or use of larger collars, or both, permits carrying appreciably more weight without increasing hole deviation.

2. The previous Conclusion 2 is reversed. It would not be desirable to carry those greater weights with *6⅝-inch collars in 7⅞-inch hole and with no stabilizer,* because this would result in appreciably more deviation.

Examples

Pounds/Inch	Pounds	Degrees
3810	30,000	12½
5250	41,000	18¼
9300	73,000	29½

3. The previous Conclusion 3 is reversed. Use of larger collars and/or one stabilizer could be useful.

4. The previous Conclusion 4 is reversed. A decrease of weight results in an appreciable decrease of deviation.

Example for 6⅝-Inch Collars in 7⅞-Inch Hole With No Stabilizer

Pounds	Degrees
30,000	12½
20,000	7½

5. Less weight should be carried to maintain a small deviation, but this weight would not be so exceedingly small as in the case of a 15-degree dip.

Examples for 5 Degrees

Collars	Hole	Stabilizer	Pounds/Inch	Pounds
6⅝	7⅞	None	1780	14,000
6⅝	7⅞	One	2220	17,500
8	8¾	None	2500	22,000
8	8¾	One	3000	26,000
11¼	12¼	None	4100	50,000
11¼	12¼	One	5100	63,000

Thus a 12¼-inch hole could be maintained within a 5-degree deviation while carrying 5000 pounds per inch, i.e., drilling could be performed as if the formations were lying horizontal. Even drilling an 8¾-inch hole with 8-inch collars would not be too unsatisfactory.

Figure 4B shows that, contrary to the 15-degree dip case, the use of several stabilizers would result in an appreciable increase of equilibrium hole deviation.

Examples for 30,000 Pounds, 6⅝-Inch Collars, 7⅞-Inch Hole

No stabilizers .....12½ degrees
Several stabilizers .....22 degrees

Use of several stabilizers before the angle builds up could still be useful in decreasing the rate of angle buildup. In view, however, of the much higher value of the equilibrium angle in the case of the 45-degree dip, the rate of buildup would be higher. Therefore, the beneficial effect of several stabilizers must be smaller in the case of a 45-degree dip than in the case of a 15-degree dip.

General Remarks. The curves of the two cases shown in the figures seem to be not at all similar. But were the Figures 1B, 2B, 3B and 4B expanded to include larger values of hole inclinations, the curves for the 45-degree dip would also level off as hole inclination approaches the dip angle.

All the figures of this paper indicate that hole deviation is smaller than formation dip. That statement is quite general. Within the range of condition actually encountered in drilling, the equilibrium hole angle is always less than formation dip, except for very small dips such as one degree, for which the hole inclination may be more than the dip.

In the mathematical study, upon which this paper is based, an assumption is made, according to which the hole drifts updip. Although that assumption does not always hold exactly true in actual conditions, the conclusions drawn from the mathematical study seem to be in agreement with observed results.

Conclusions

1. Without the knowledge of formation dip, it is always possible to determine how much more weight may be carried, without building more angle, by use of larger collars, and if necessary drilling larger holes, and use of one properly located stabilizer.

2. In formations which are very "crooked" in spite of moderate dip angle (such as 15 degrees),

   a. It might be exceedingly expensive to maintain a hole angle which is appreciably smaller than the dipangle;

   b. The best technique is deliberately to accept a hole angle approaching the dip angle, in which event one might carry the same weight that would be carried were the formation lying horizontal;

   c. If the above technique is accepted, then use of larger collars, drilling larger holes, and using one stabilizer are inadvisable because the same additional weight carried without larger collars or hole size and without a stabilizer would result in almost the same hole angle;

   d. Use of several stabilizers (such as at the bit and at 15 and 30 feet above the bit) **before the hole angle builds up,** is useful to decrease the rate of buildup.

3. In the event drilling crooked formations with a hole angle close to the dip angle is not permissible, either because formations are too steep, or for any other reason, then the preceding conclusion is reversed; use of larger collars, drilling larger holes, and using one properly located stabilizer are profitable.

4. In the event the formation is known to be "crooked" but the dip is not known, then the best choice is to run the risk of sometimes using unnecessary equipment.

5. It is recommended that, whenever needed, dipmeter surveys be run if only for the purpose of choosing the most suitable straight hole drilling technique.

ACKNOWLEDGMENT

The authors wish to thank the Stanolind Oil and Gas Company for willingness to give the findings of this paper to the drilling industry. They are grateful to H. B. Woods, Hughes Tool Company, for having read the paper and advised improvements. This paper was originally presented at the February, 1956, meeting of the Denver Chapter of the American Association of Oilwell Drilling Contractors.

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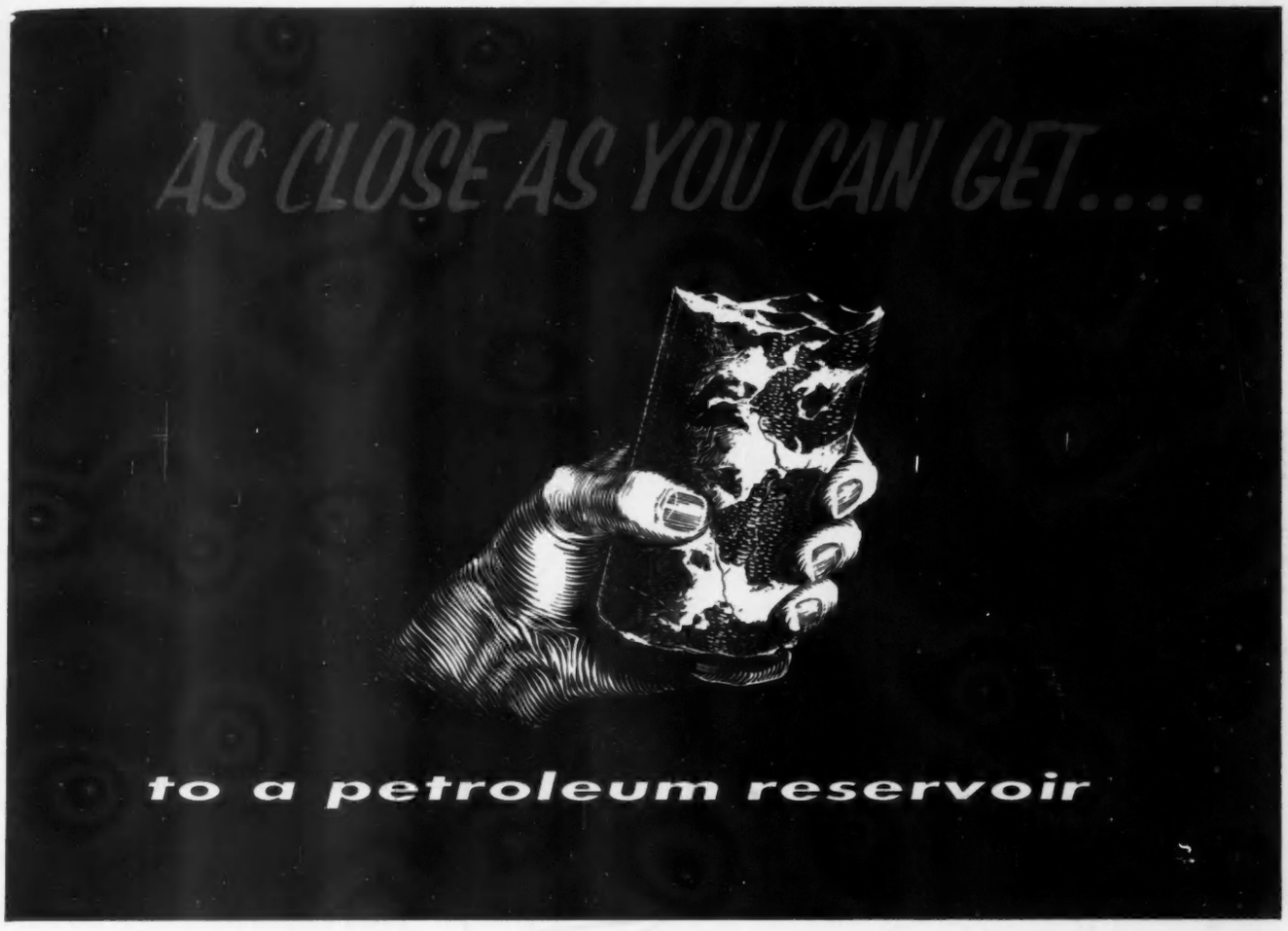
[3] Woods, H. B. and Lubinski, Arthur: "Use of Stabilizers in Drill-Collar Strings," *The Oil and Gas Journal,* April 4, 1955; "Use of Stabilizers on Controlling Hole Deviation," API Paper No. 851-29-H, March 23, 1955.



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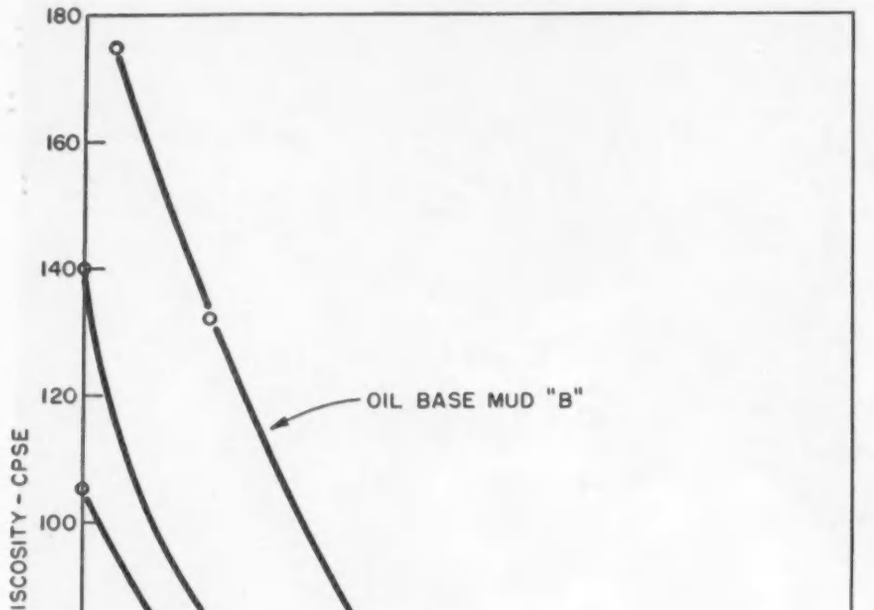

FIGURE 1—Effect of temperature on viscosity of oil base muds.

New Oil Base and Invert Emulsion Muds Introduced

Here's a new oil base mud—successfully field tested—that can be easily prepared with conventional rig mixing equipment. Treated with stabilizing agents, the mud displays an excellent resistance to water, solids contamination and high temperature. The concentrate can also be used to compound a water-tin-oil emulsion mud or the oil base mud can be converted to a water-in-oil emulsion.

By J. L. LUMMUS and B. V. RANDALL
Stanolind Oil & Gas Company
Tulsa

OIL BASE MUDS are primarily used for drilling and completing water-sensitive producing formations and for obtaining "native state" cores for reservoir evaluation tests. On several occasions, oil base muds have been successfully used in deep wells under temperature conditions which normally cause conventional water base muds to solidify. Specially treated oil base muds have found use as packer fluids, gun perforating fluids, and for placement behind casing as a protection against corrosive waters.

There has been a considerable amount of information published on oil base muds and, as a result, the industry is well aware of the advantages of oil base muds as completion fluids. Production data on wells completed with oil base mud as compared to water base mud completions have been particularly impressive.[1] In spite of proven advantages, oil base muds have not been widely used in areas other than the West Coast because of high material, transportation, and storage costs and, in some instances, inability to tolerate water contamination.

Some of these disadvantages have been overcome by the development of water-in-oil emulsion muds,[2,3] which have similar properties to oil base muds. The main advantage of water-in-oil emulsion muds, which are often referred to as invert emulsions by many mud technologists, is that they are not adversely affected by water and shale contamination, and as a result such compositions have been successfully used as both drilling and completion fluids. Oil base muds, however, are still considered superior to water-in-oil emulsion muds for obtaining "native state" cores and for various high temperature applications.

Procedure. The viscosity, gel, and fluid loss properties of the oil base and water-in-oil emulsion muds in the temperature range from 80° to 190° F. were determined by standard

API procedures.[4] Fluid loss values in the temperature range from 250° to 350° F. were obtained using a special high temperature, high pressure tester.[5] The gel properties in the temperature range from 190° to 350° F. were determined after exposure of the muds to the indicated temperatures with only enough cooling to prevent vaporization. The weight suspension tests were conducted by placing samples of oil base muds weighted to 16 pounds per gallon in three-foot sections of two-inch pipe and exposing the muds to a temperature of 350° F. for two weeks. The test cells were equipped with side taps at one-foot intervals so that portions of the mud column could be removed separately for weight determinations after the exposure period. The water and shale contamination tests were conducted as follows: The contaminated oil base mud samples were placed in a laboratory roller oven and agitated for 96 hours at a temperature of 160° F. The samples were then removed from the oven, cooled to 80° F., and the properties determined.

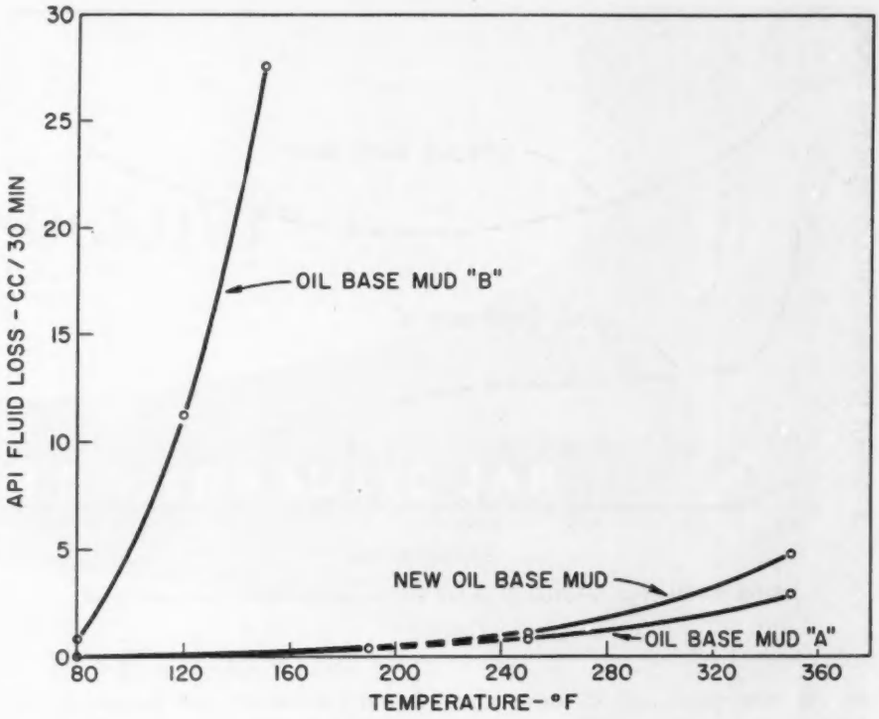

FIGURE 2—Effect of temperature on fluid losses of oil base muds.

Results. Table 1 shows the range of concentration of ingredients and treating agents found suitable for preparing and maintaining the new oil base mud. Figures 1 through 3 and Table 2 show the effects of elevated temperatures on the viscosity, gel, fluid loss and weight suspension properties of this oil base mud. Table 3 shows the effect of water and shale contamination on the properties of the oil base mud and the effect of these contaminants on the mud treated with Stanolind's peptizer *A* and calcium chloride. Table 4 lists treatments which may be used for controlling the physical properties of the oil base mud.

The results of field use of this new mud as a coring, completion, perforating, and drilling fluid are summarized.

The range of concentration of the oil base mud concentrate and other constituents for compounding a water-in-oil or invert type emulsion mud is shown in Table 5. Table 6 shows the composition and properties of typical water-in-oil emulsions and the results of converting the oil base mud to a water-in-oil emulsion.

Discussion—Oil Base Mud

Composition. The composition of this improved oil base mud is shown in Table 1. The dry concentrate is packaged in 100-pound bags and consists of a mixture of clay, a partially polymerized organic material, a base, and a catalyst. When dispersed in an oil, the agents react to provide a gel quality or "body" to the hydrocarbon base.

Treatment with caustic soda, calcium chloride, and peptizer *A* may be desirable for proper compounding of the oil base mud. The function of the caustic soda is to adjust the properties of the oil base drilling fluid to compensate for differences in the characteristics of base oils. Peptizer *A* and calcium chloride are added to protect

TABLE 1

Composition of Oil Base Mud (API Barrel)

Ingredients:	
40 gallons field crude oil or refined oil (18-32 API gravity).	
40-50 pounds dry concentrate.	
Treating Agents:	
0-1 pound caustic soda.	
0.2-2 pounds calcium chloride.	
0.1-1 pound peptizer *A*.	

TABLE 2

Suspension of Weighting Material Test Mud 16 lbs/gal

	TEST A Weight, Lb./Gal.	TEST B Weight, Lb./Gal.
Top Portion	14.9	14.8
Middle Portion	16.3	16.4
Bottom Portion	16.7	16.8

TABLE 3

Effect of Water and Shale Contamination on New Oil Base Mud

	Water Content Percent by Vol.	—40+325 Shale Added Lb./Bbl.	Stormer Viscosity cp	STORMER GEL STRENGTH, GRAMS		Fluid Loss cc/30 Min.
				Initial	10 Min.	
Water:						
Oil base mud*	1	....	103	6	14	0
Oil base mud	20	....	73	1	1	0.2
Oil base mud + 1 lb./bbl. peptizer *A* + 2 lb./bbl. calcium chloride	20	....	142	4	12	0
Shale:						
Oil base mud*	1	40	75	7	15	2.0
Oil base mud + 1 lb./bbl. peptizer *A* + 2 lb./bbl. calcium chloride	1	40	97	7	18	0

* Prepared by addition of 45 lbs. dry concentrate and 0.5 pound caustic soda to 0.9 barrels of a 30 API gravity crude oil.

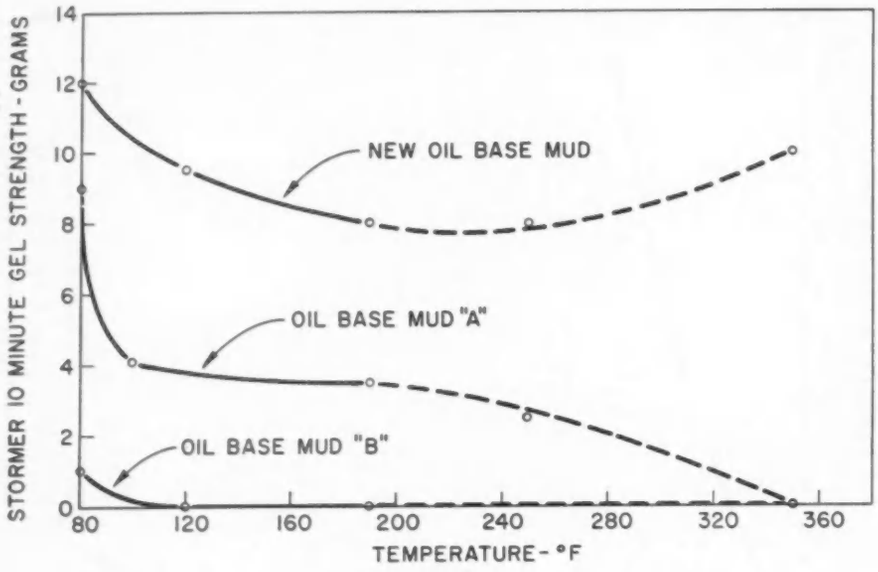

FIGURE 3—Effect of temperature on 10 minute gel strength of oil base muds.

the oil base mud against water and solids contamination which may occur during displacement.

Preparation. Pilot tests are usually conducted prior to mixing the quantity of mud required for a particular job in order to select the most suitable base oil and to determine the amount of concentrate and treating agents necessary to produce an oil base mud with desirable properties.

The base oil may be a crude oil, topped crude, or refined oil, preferably in the API gravity range from 18 to 32 degrees. Crude oils obtained from different producing areas classified as paraffin base, mixed base, and asphalt base have been tested and found satisfactory for preparing this mud. In some instances crude oils of high aromatic content have been found to require additional chemicals for satisfactory adjustment of the mud properties.

After completing the pilot testing, the pre-determined amount of concentrate is added to the base oil through the hopper. This concentrate is readily wet by oil and therefore can be mixed rapidly without plugging the hopper. If required, the caustic soda is then added through the chemical barrel in a 35 to 50 percent solution, and the pits gunned for approximately 30 minutes to insure inadequate mixing. As a final step, 0.1 pound per barrel peptizer *A* and 0.2 pound per barrel of calcium chloride are generally then added and the pits gunned for an additional 30 minutes.

The density of the oil base mud at this stage of preparation is from 7.8 to 8.5 pounds per gallon, depending on the amount of concentrate and the gravity of the base oil. Densities up to 17 pounds per gallon can be obtained by addition of barite.

Properties. The properties of this oil base mud as normally determined by standard API procedures are similar to other commercially available oil base muds.[6,7] Experience has shown, however, that oil base muds which have identical API properties, i.e., viscosity, gel strength, fluid loss, may differ quite markedly under test conditions which more nearly simulate actual field usage at elevated temperatures. Effects of these conditions are discussed herewith.

Effect of Elevated Temperatures

Viscosity. Figure 1 shows the effect of temperature on the viscosity of the new oil base mud as compared with two other commercially available oil base muds, designated as muds *A* and *B*. The percentage reduction in viscosity of the new mud and mud *A* over the temperature range from 80° to 190° F. is approximately 65 percent, whereas the viscosity of mud *B* was reduced by 90 percent. This shows the better temperature stabilization characteristics of the new formula since both mud *B* and the presently described oil base mud were prepared with similar crude oils.

Fluid Loss. Figure 2 shows the effect of temperature on the fluid losses of these same oil base muds. In conducting the fluid loss tests in the 250° to 350° F. temperature range the fluids were protected from the air, and the downstream pressures were kept at 1000 pounds per square inch to prevent loss of filtrate by vaporization. From calibration of the instrument at lower temperatures, it is believed that these results are equivalent to API fluid loss values.

TABLE 4

Control of Physical Properties of Oil Base Mud

Condition to be Corrected:	Treatment:
Low Viscosity and gel	Add concentrate and/or caustic soda
High viscosity and gel	Add low viscosity crude or fuel oil
Large amount of water contamination	Add peptizer *A* and calcium chloride
High fluid loss	Add peptizer *A* and calcium chloride Gun pits

TABLE 5

Composition of Water-in-Oil Emulsion Mud

40-50 pounds dry concentrate.
0.4-0.6 barrels of diesel oil or low viscosity crude oil.
0.4-0.6 barrels of either fresh or brine water.
1.5-2.5 pounds of peptizer *A*.
3-5 pounds calcium chloride.

TABLE 6

Properties of Water-in-Oil Emulsion Mud

MUD DESCRIPTION	Stormer Viscosity cp	STORMER GEL STRENGTH GRAMS		Fluid Loss cc/30 Min.
		Initial	10-Min.	
Prepared Initially:				
0.5 bbls. diesel oil, 0.5 bbls. fresh water, 50 lbs. concentrate, 2 lbs. peptizer *A*, 4 lbs. calcium chloride	57	1	2	0
0.4 bbls. diesel oil, 0.6 bbls. fresh water, 40 lbs. concentrate, 1.5 lbs. peptizer *A*, 3 lbs. calcium chloride	115	2	7	0
Conversion:				
Oil base mud	103	6	14	0
+ 2 lbs./bbl. peptizer *A*, + 4 lbs./bbl. calcium chloride, + 20 percent diesel oil, + 80 percent fresh water	139	3	9	0

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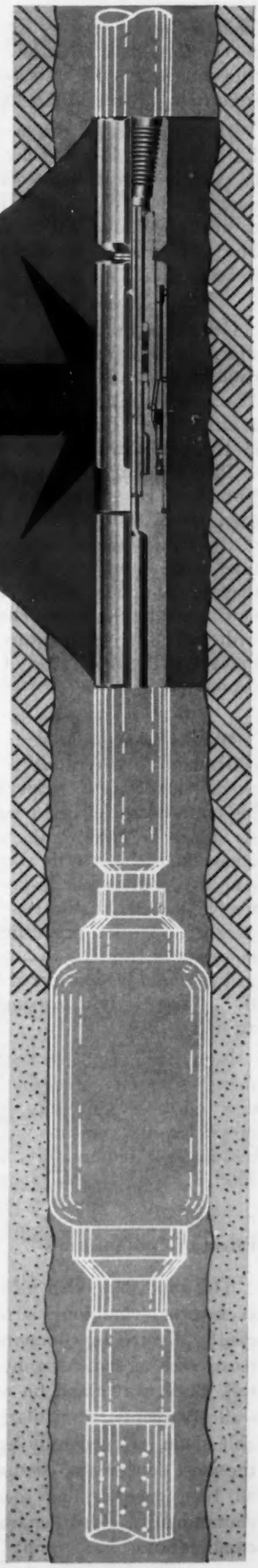

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Unseating and releasing the packer or anchor on completion of drill stem tests is easier and faster with Halliburton's Hydraulic Jar, which has performed with outstanding success in several years of severe field testing. It utilizes the hydrostatic pressure of the well fluid to deliver the necessary "knock-out" punch... relieving strain on the testing string. Jar design, employing only one moving part, makes the operation very simple. When adjusted into the testing string, only 40 inches are added to its length.

THE DEEPER THE HOLE, THE HEAVIER THE BLOW

When a pull is applied to the pipe against resistance, the sealing packer acting as a piston in the hydraulic system of the Jar works against the hydrostatic pressure of the well fluid. After a short travel of the mandrel, the hydraulic system releases the pressure suddenly, allowing the mandrel to move freely. The tension in the pipe supplies the energy to cause the shoulder on the mandrel to deliver a blow to the stuck packer or anchor. The deeper the hole and the greater the hydrostatic pressure of the well fluid, the stronger the blow. Jar can be cocked and re-cocked again and again by slacking off pipe weight, as when Packer is set.

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251 SERVICE CENTERS—JUST MINUTES AWAY FROM ANY RIG

This is borne out by the smooth curves plotted between low temperature values in API tests and results from high temperature tests.

The fluid loss of this new mud is 1.2 cc at 250° F. and 4.8 cc at 350° F., which compares favorably with mud *A*, which had a fluid loss of 1.1 cc at 250° F. and 3.0 cc at 350° F. Mud *B* filtered too rapidly at 250° F. to be measured.

Gel Strength. Figure 3 shows the effect of temperature on the gel strength of the oil base muds studied. The new mud and mud *A* maintain a satisfactory 10-minute gel strength in the temperature range from 80° to 190° F. Mud *B* had no measurable 10-minute gel strength at temperatures above 100° F. The significance of the data obtained in the temperature range from 190° to 350° F. is that the 10-minute gel strength of the new mud tends to increase slightly with increasing temperature, whereas the gel strength of mud *A* tends to decrease.

Weight Suspension. Tests were also conducted to determine if the mud would satisfactorily suspend weighting material at elevated temperatures. As shown in Table 2, the weight increase in the test cells was only 0.7 and 0.8 pounds per gallon, respectively, which indicates excellent weight suspension properties. Weight increases of from 2.5 to 5 pounds per gallon would be considered as indicative of poor weight suspending properties.

It is concluded from the results of these high temperature tests that this new oil base mud has satisfactory properties for use in wells having bottom hole temperatures as high as 350° F.

Effect of Contaminants

This mud, like other oil base muds or inverted emulsions, is not significantly affected by common contaminants such as cement, anhydrite, and salt. Fresh water and bit cuttings or wall fragments, particularly hydratable shale, are generally regarded as the most detrimental contaminants of oil base type drilling muds. These contaminants, either separately or in combinations, can result in severe maintenance and operational problems.

Peptizer *A* and calcium chloride protect this oil base mud from the deleterious effects of fresh water and shale contamination. These chemicals apparently react to form a preferentially oil wet coating on particles contained in the mud, thus preventing them from becoming hydrated and dispersed if contacted by water. This effect is illustrated in Table 3.

Contamination of the mud with 20 percent fresh water causes a significant decrease in gel strength and a slight increase in fluid loss. Contamination with 40 pounds per barrel shale had no effect on the gel strength but significantly increased the fluid loss. When the mud was pretreated with one pound per barrel peptizer *A* and two pounds per barrel of calcium chloride, these contaminants had no appreciable effect on the gel strength and fluid loss properties.

The results of these tests show that addition of small quantities of treating additives (peptizer *A* and calcium chloride) stabilizes this mud against the effects of water and shale contamination.

Control

This oil base mud will normally require little attention after the initial mixing; however, should adjustment of the properties be required, the treating procedures shown in Table 4 are applicable. For example, if the mud becomes contaminanted with a large amount of water, treatment with peptizer *A* and calcium chloride is recommended. The same treatment would also be effective for reducing fluid loss.

Field Tests

Woodbine Formation, East Texas —Coring—The oil base mud has been successfully used as a coring, completion, perforating, and drilling fluid. A typical application was the coring of approximately 145 feet of the Woodbine formation in East Texas. Overall core recovery was approximately 81 percent and coring rates in the sand and shale formations were four and thirty minutes per foot, respectively. After each core was cut, the hole was reamed from 6⅛ to 7⅞ inches. No difficulty was encountered with this fluid during the coring and reaming operations, and an examination of the cores indicated that no noticeable flushing or invasion of mud or mud filtrate had occurred.

Some difficulty was encountered in displacing the high viscosity water base mud from the hole, and this mud together with some mud which could not be removed from the partially buried steel pits increased the water content of the oil base mud to approximately nine percent. This contamination, although it had no serious effect on the mud properties, could have propably been minimized by lowering the viscosity of the water base mud prior to displacement operations.

Matagorda County, Texas—Perforating and Completion. In another operation in Matagorda County, Texas, the oil base mud was weighted to 16.5 pounds per gallon and spotted in the lower section of the well bore for running a perforating gun and the setting of a packer. The bottom hole temperature in this well was 325° F. No thickening at the interface of the oil base and water base muds was apparent as the perforating gun was run to bottom. When the oil base mud was circulated from the hole after four days of formation testing, no hard settling of solids was evident.

Other successful applications include the use of this mud for drilling and completing shallow wells in Pontotoc County, Oklahoma, and as a completion fluid for high temperature wells in Colorado County, Texas.

Water-in-Oil Emulsion Mud. The dry concentrate and treating additives can also be used for preparing a water-in-oil emulsion mud having excellent properties. The composition of the mud is shown in Table 5.

The preferred method of preparing the water-in-oil emulsion mud is to add the concentrate, peptizer *A* and calcium chloride to the oil followed by addition of the water. Addition of the ingredients in this order insures the formation of a water-in-oil type emulsion. Typical examples of emulsions prepared in this manner are shown in Table 6. These examples illustrate the effect of concentration of the internal phase (water) has on the viscosity and gel properties of the emulsion. In the first example the

Continued on Page 168

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THE WORLD'S LARGEST INDEPENDENT OILFIELD SUPPLY AND SERVICE ORGANIZATION

How to Select and Handle Wire Rope

Here are calculations to keep the guesswork out of figuring proper diameter, length, string-up and cut-off of wire rope.

By TY GIBBS, Bethlehem Supply Company, Houston

THE FIRST STEP in any program involving the safe use of wire rope is the selection of the rope itself. Once the diameter is determined the proper grade of rope and the correct construction for the job to be done are selected. In discussing oil country ropes in general and, in this case, rotary drill lines in particular, considerations include the three grades of wire; mild plow, plow, and improved plow steel. In a few cases, the fourth or premium grade of steel wire, aircraft quality is considered. Wire rope cores include sisal fiber, plastics and independent wire rope cores. Constructions, while rather definite within given applications, vary from the simple sand line made of six 7-wire strands closed over a fiber core, through favored 6 x 19 Seale for rotary lines, to the complex, "rope within a rope," 18 x 7 tubing and rod line of non-rotating construction.

Following choice of rope to be used comes installation. Here direction of travel is important to good spooling. Good spooling is a requirement for safe operation. In transferring a new rope to the hoist drum, the direction of drum travel should govern the position of the shipping reel. That is, if the drum winds from the bottom, the rope is taken from the bottom of the reel. In the event the drum winds from the top, the rope should be taken from the top of the reel.

In stringing up a new line by pulling it through the system at the time of removing the old line, a swivel type grip is recommended to avoid transfer of twist from the old line to the new. It is also good string-up practice to hang the traveling block in the derrick or mast and, if suspension is not practical, to brace it upright on the derrick floor in such a manner that the rope does not scrape the guards. However, this is also impractical where drawworks drums are grooved, as raising the block from the floor leaves too much rope on the drum.

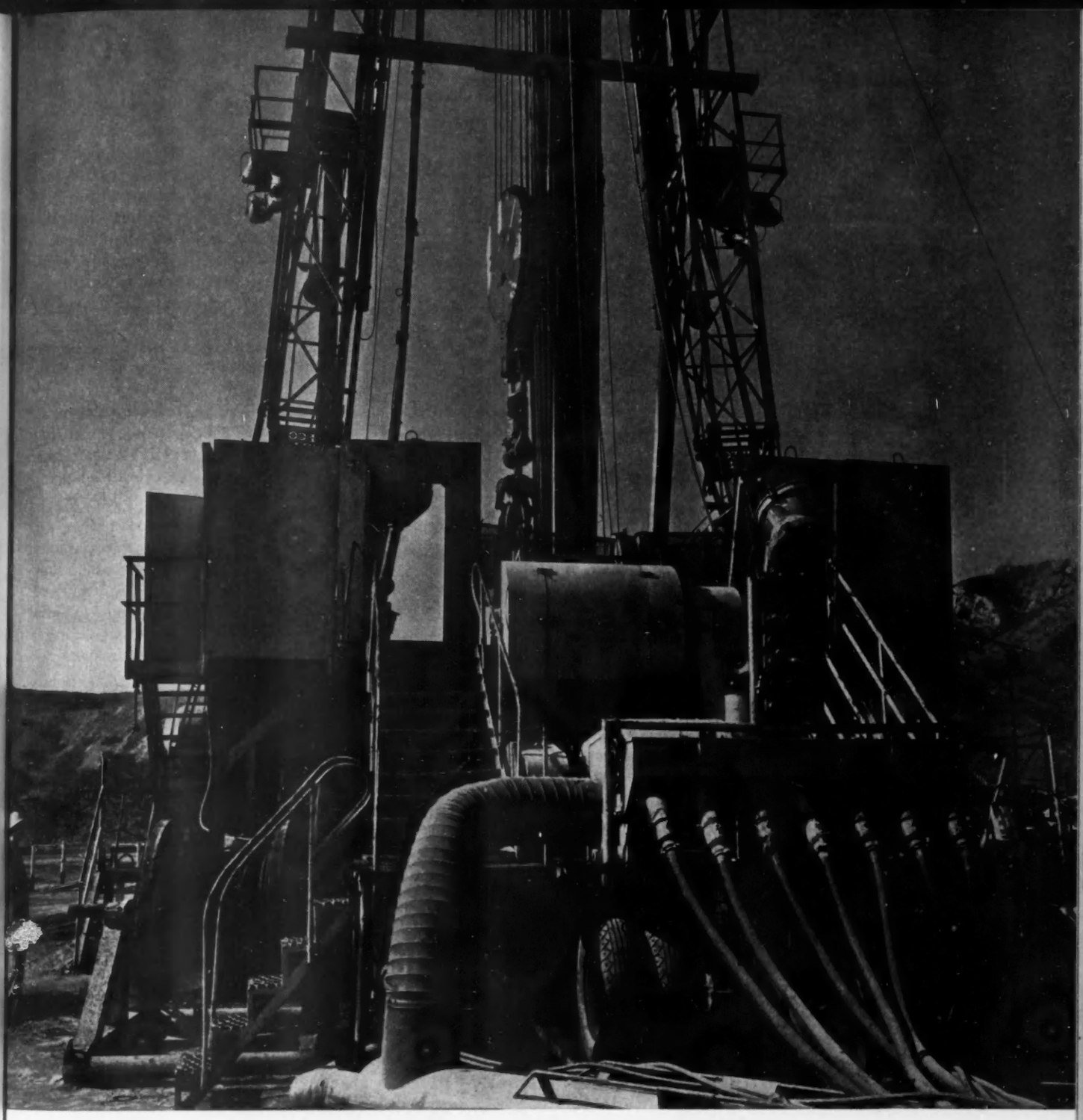
Following a new rope installation, it is always good practice to "break the line in" by running the lightly loaded blocks up and down the derrick a few times. This allows the rope to become adjusted to the operation, some constructional stretch is removed, and the strands become initially set on the rope center.

Drum-line stabilizers or guides should be properly positioned above the drawworks drum. The use of weight buckets is preferred over the triangular suspension used on many masts and some derricks. The use of weight buckets permits adjusting the pull of the line guide against the drum line. With triangular suspension the line pulls the roller back and forth, making the roller serve only as a stabilizer to reduce line whip in the drum line.

Wire rope, and particularly rotary drill lines, are constantly subjected to several kinds of stress. The definition of stress is "load applied to an object in such a manner that the object tends to change its shape." Wire rope is in tensional and torsional stress when loaded; in bending stress when traveling over sheaves or winding on a drum; in compressive stress if, while under load, the line suddenly becomes slack. This happens in sand, bailing, core retriever, cable tool and swab lines if a bridge down hole is struck or the swab or tools strike the fluid level too fast, oftentimes "bird-caging" the rope with the resulting "popped" core.

Moderate line speeds are to be maintained as speeds above 4000 feet per minute are destructive and tend to shorten rope life.

Lubrication is a very important factor in the life of wire rope. The rope, during manufacture, is thoroughly lubricated at each stage, both internally and externally. Despite these precautions, some ropes reach the field in a dry condition. This might be due to factors such as extreme hot or cold weather, solvents contained in rig washing compound, or additives contained in the drilling fluids that might splash on the line. In the event a rope becomes dry, its service life can be appreciably lengthened by the application of most any oil or grease found around the rig. The tool joint and drill collar thread compounds are ex-



Wire Rope at Work—Of interest to drilling men is this all-electric rig owned and operated by the Shell Oil Company. When photographed, it was redrilling a 12,500-ft well that had ceased producing in profitable volume. The locale of the job was the rugged, hilly country northwest of Ventura, California.

The rig is controlled by a series of push-buttons arranged on an operating console. It uses the familiar jackknife type of mast, 136 ft high. For the job shown in the photograph above, the outfit was equipped with 2500 ft of Bethlehem wire rope, 1¼-in. diam, Purple Strand grade. A very sound choice, for Purple Strand has the high strength needed in deep drilling, as well as the toughness and dependability that mean a long and useful life.

Bethlehem Steel Company, Bethlehem, Pa. On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Mill depots and distributors from coast to coast stock Bethlehem rope for the following industries and numerous others:

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FIGURE 1—Rotary Drilling Rig String Up Diagram

Company SQUARE HOLE DRILLING CO. **Rig. No.** 13 **Toolpusher** HOLLIGAN **Date** 2/1/56
Length of Line in String Up 1,334 **No. Lines** 8 **Dia. of Line** 1¼"

Pick-up Points at Crown Sheave: Measured Drum from End of Line

Elevators Up	968	1022	1076	1139	1184
Elevators Down	224	464	704	944	1184
Rope Travel Through Sheaves	744	558	372	186	0

Last portion of line in String Up to reach the drum when a stand is hoisted—*

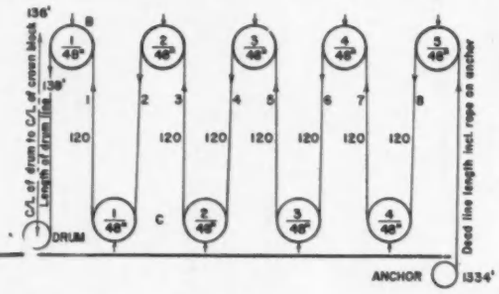
744
139—Drum Line

605
600 Nos. 1, 2, 3, 4 & 5 lines

5′ Therefore the rope section to hit the drum last when hoisting a stand is 5 feet up on No. 6 line or at No. 3 trav. blk. sheave.

Derrick Floor Level

* This measurement to be taken with elevator latched at rotary table pick-up.



Pick-up Points at Traveling Block Sheaves

Elevators Up	995	1049	1103	1157
Elevators Down	344	584	824	1064
Rope Travel Through Sheaves	651	465	279	93

C/L of drum to D.F. = 3′
Pitch Dia. of Drum = 32¼
Drum Circumference = 8.5′

Rope on drum at lower pick-up
1st layer = 10 Wraps x 8.5 = 85′
2nd layer = Wraps x =
Total Rope on Drum 85

Centerline of travelling block to top of elevators = 22′
*Top of elevators to derrick floor = 3′
Centerline of traveling block to Derrick Floor = 25′

Equipment Notes and Measurements

Make, Model & Height of Mast or Derrick STD. DERRICK 136
Make & Model Drawworks Drum Dimensions 31 x 50 S or G GROOVED
Make & Model Crown Block Sheave Diameters 48"
Make & Model Traveling Block Sheave Diameters 48"
Make & Model Hook
Elevator Bails—Length 9′
Average Length of Drill Pipe Stand 93
Type Dead Line Anchor WRAP AROUND BELOW DERRICK FLOOR

To Determine Length of Cut

Length and Construction Line Recommended:	5000		
Length Line Required to String Up	= 1334		
Reserve Rope Length	= 3666		
Recommended Ton Mile Interval Between Cuts	= 1500		
Total Ton Mile Expectancy—Estimated	= 56000		
Recommended Lengh to Cut	= 98		
Length of Cut Measured in Wraps on the Drum	= 11.5 DRUM WRAPS		
C/L of drum to C/L of crown block		=	136′
C/L of drum to derrick floor		=	3′
			139′
C/L of Crown Block to derrick floor		1—Add	
C/L of travelling block to top of elevators		=	22′
Top of elevators to derrick floor		=	3′
			25′
C/L of travelling block to derrick floor		2—Add	
Derrick floor to C/L of crown block		=	139′
Derrick floor to C/L of travelling block		=	25′
			114′
This difference equals C/L of crown to C/L of travelling block		3—Subtract	
Crown Sheave Circumference =	one fourth = 3′		
Traveling block sheave circumference =	one fourth = 3′		
		4—Add	
Add steps 3 and 4—this sum equals length of lines between blocks: Elevators Down		Step No. 3 =	114′
		Step No. 4 =	6
		5—Add	120
Length of lines between the blocks: Elevators Down	=		120′
Average length of drill pipe stand	=		93′
		6—Subtract	27′
This difference equals length of lines between blocks with the Elevators Up	=		27′
Drum line length equals C/L of drum to C/L of crown block plus ¼ of crown block fast sheave circumference = 136+3=139			
Dead Line length equals the following measurements:			
Derrick floor to C/L of crown block		=	139
¼ of dead line sheave circumference		=	3
Rope on anchor plus distance anchor might be below D.F.		=	18
		Add =	150
Total length of line to string up equals the following:			
Rope on drum (elevators down)		=	85′
Length drum line		=	139′
Length of line between the blocks (elevators down)	120′		
Multiplied by the number of lines strung	= 8 x 120′	=	960
Length of dead line—incl. rope on anchor		=	150
		Add =	1334

Length to string up 1334′
Rope travel over sheaves determined as follows:
Multiply average length of drill pipe stand by the number of lines strung to determine rope travel over No. 1 crown sheave. From this amount, again subtract the drill pipe stand length to find the rope travel over the No.1 travelling block sheave. Continue subtracting the drill pipe stand length from the last amount to find rope travel over the other sheaves in the following order: No. 2 crown, No. 2 travelling, No. 3 crown, etc., until the crown dead sheave is reached where rope travel is zero.

cellent rope lubricants and the used motor oils are good substitutes.

Design factors or the ratio of the breaking strength of the rope to the applied load (commonly called factors of safety), might vary from 2 to 10. The reason for calling the ratio a design factor rather than a safety factor is that, depending upon condition of use, the lower ratio might be safer than a higher one. Higher design factors result in proportionately higher or longer rope life. The lighter a given rope is loaded, the longer it can be expected to last in service. In many operations, such as rotary drilling, rope is considered expendable in that it is often economical to sacrifice rope life to effect greater overall economy in rig operation.

Dead-line anchors should be of the wrap-around type with the diameter of the drum equalling at least 12 rope diameters. They should be equipped with a clamp long enough to grip the rope securely without damaging it for later travel over the sheaves.

The critical wear and fatigue points in the string-up will be noted in the diagram. These include drum, crown and traveling block, sheave contact points when the elevators are at the two pick-up positions, the crown block dead sheave, dead line anchor and to a lesser extent the weight indicator clamp if a type of deforming clamp is used.

Prior to discussing rotary drill line moving and cutting programs, it is necessary to agree or accept a means of measuring wire rope service. The best means devised yet is the ton-mile. The definition of a ton-mile is the work performed in hoisting one ton one mile, or one quarter ton four miles. It is a measure of work performed by a wire rope in hoisting service and differs from horsepower in that time is not considered. The present ton-mile formula is not 100 percent correct and the number of variable factors to consider prohibits absolute accuracy. Therefore, comparison of ton-mile service records should be limited to like-sized equipment operating under similar conditions in or near the same area.

In a well designed rotary drill line moving and cutting program, the following steps are to be considered:

1. String up diagram—This will not only show the actual amount of

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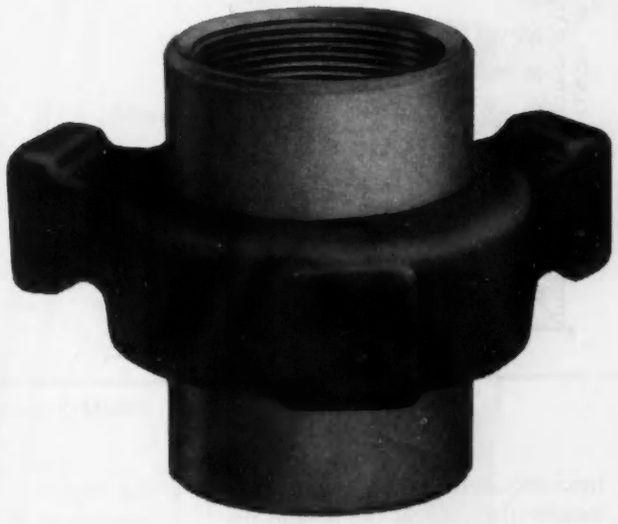
of High and Low Pressure, Quick Change
UNIONS

1,000 lb. test
2,000 lb. test



4,000 lb. test
6,000 lb. test
10,000 lb. test
15,000 lb. test

Quick and easy to make or break, Guiberson's Unions are ideal for a multitude of uses... give a positive, leakproof seal, with minimum upkeep. Guiberson's low pressure unions 1" through 10" sizes have metal to metal seats, feature a convenient 3-lug wing nut.

High pressure unions are made in 1" through 4" sizes. 6,000 lb., 10,000 lb. and 15,000 lb. unions incorporate the pressure-molded Seal-O-Matic Ring. All high pressure unions are forged steel.

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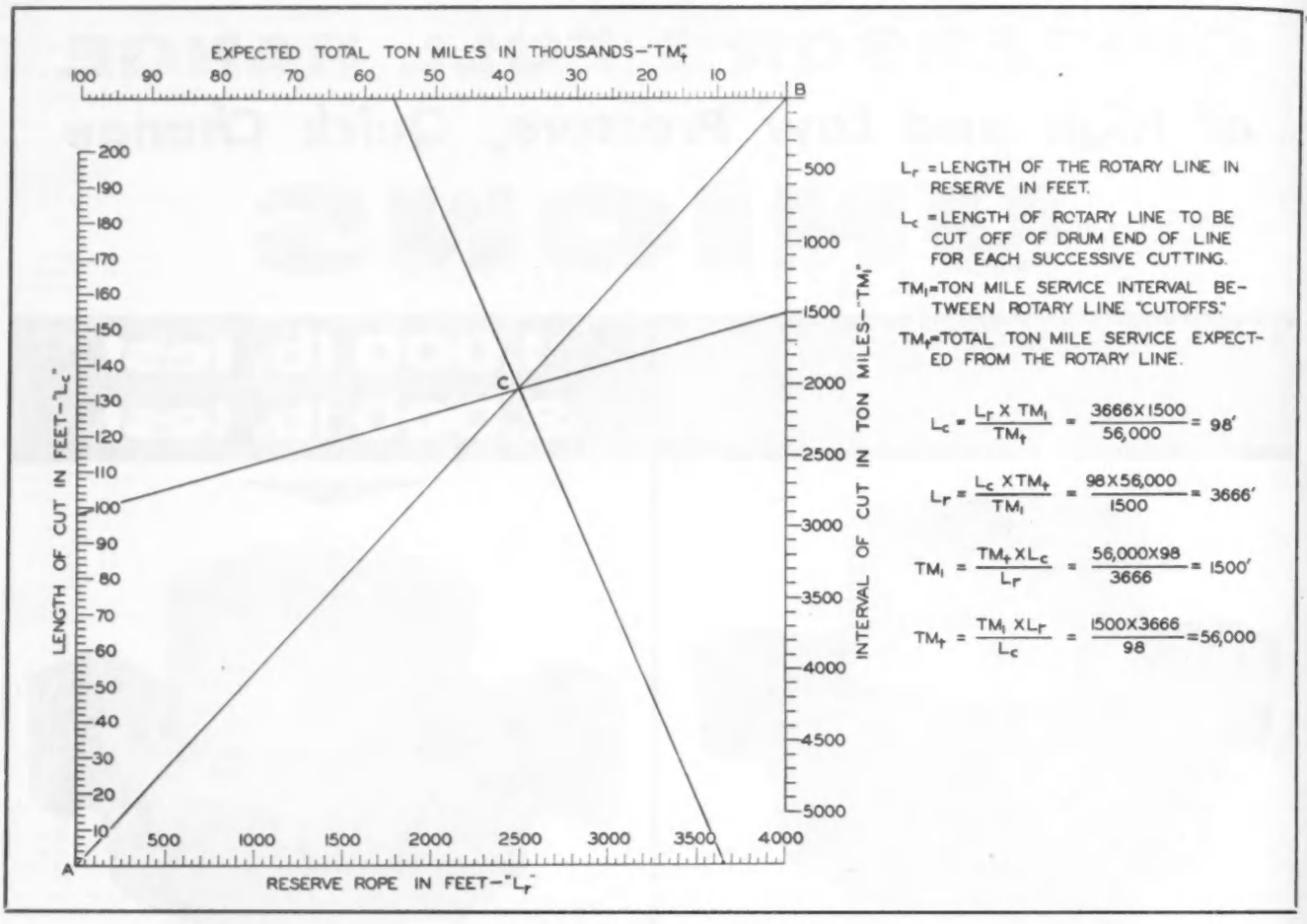

EXPECTED TOTAL TON MILES IN THOUSANDS—"TM$_t$"
100 90 80 70 60 50 40 30 20 10
B
C
A
LENGTH OF CUT IN FEET—"L$_c$"
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
INTERVAL OF CUT IN TON MILES—"TM$_i$"
500 1000 1500 2000 2500 3000 3500 4000 4500 5000
500 1000 1500 2000 2500 3000 3500 4000
RESERVE ROPE IN FEET—"L$_r$"
L$_r$ = LENGTH OF THE ROTARY LINE IN RESERVE IN FEET.
L$_c$ = LENGTH OF ROTARY LINE TO BE CUT OFF OF DRUM END OF LINE FOR EACH SUCCESSIVE CUTTING.
TM$_i$ = TON MILE SERVICE INTERVAL BETWEEN ROTARY LINE "CUTOFFS."
TM$_t$ = TOTAL TON MILE SERVICE EXPECTED FROM THE ROTARY LINE.
$L_c = \frac{L_r \times TM_i}{TM_t} = \frac{3666 \times 1500}{56{,}000} = 98'$
$L_r = \frac{L_c \times TM_t}{TM_i} = \frac{98 \times 56{,}000}{1500} = 3666'$
$TM_i = \frac{TM_t \times L_c}{L_r} = \frac{56{,}000 \times 98}{3666} = 1500'$
$TM_t = \frac{TM_i \times L_r}{L_c} = \frac{1500 \times 3666}{98} = 56{,}000$

FIGURE 2 (Explanation on Page 166)

rope required to string up, but it locates the critical wear and fatigue points in the rope system.

2. From the amount required to string the given number of lines, the amount of reserve rope available for moving into the string-up can be determined. It is the amount of reserve rope that determines the total service and influences the length to cut between intervals of service.
3. Diameter, grade and construction of the rope and the size equipment in use along with the area of drilling will control the ton-mile service interval between drum end line cuts.
4. Previous experience or comparative service records will indicate the total ton-mile service to be expected from a given line used under given conditions. This is generally based on a figure of so many ton-miles per foot of rope.
5. Multiply Step 2 by Step 3 and divide this product by Step 4, which is another way of saying that the length to cut is equal to the product of the reserve rope multiplied by the service interval between drum cuts and divided by the expected total service. This length cut at the proper service interval will permit the reserve rope to be moved into the system at a uniform rate by regular drum end cuts of constant lengths.
6. Check the length of cut as determined above with the rig string-up diagram to avoid the critical points of wear. A plus or minus adjustment of the length to cut is usually sufficient to adapt the length of cut to the string-up diagram.

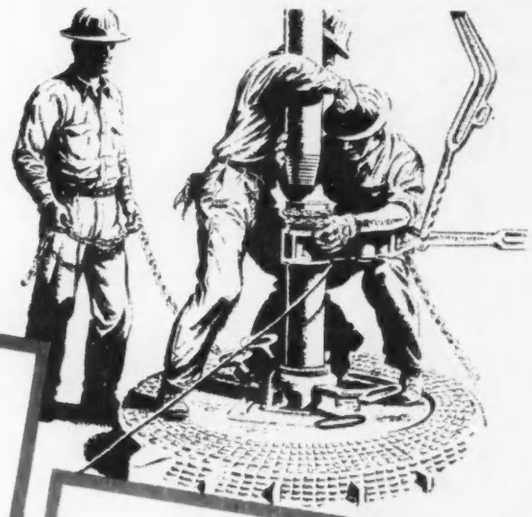
A check of the reeving or string-up diagram will show that the cut of 98 feet represents good practice, as it is not a multiple of 27 feet, the average length between pickup points on the crown and travelling block sheaves when the elevators are "up." More important is that the cutoff length of 98 feet will not divide evenly into multiples of the 120-foot line lengths or into multiples of the 139-foot drum line length or the dead line length—nor does it equal an even number of drum wraps.

The points marked *A*, *B* and *C* indicate the points of greatest wear and abuse, that is, the drum, including flange turnbacks and crossovers, and the points of crown and travelling block sheave contact.

It might be well to note that the length of the lines between the blocks with the elevators at the lower, or rotary table pickup is the more important factor in governing the length to cut for the following reasons: The rotary table pickup is made at a rather constant height above the rotary table whereas due to the difference in length of the drill pipe stands of 1 to 4 feet the upper pickup is made at varying heights, thus constantly changing the length of the lines between the blocks at the upper pickup position.

In the diagram above, rather conservative performance figures are used and the length of cut was determined as follows:

Length of rope purchased	5000 feet
Length required to string 8 lines	1334 feet



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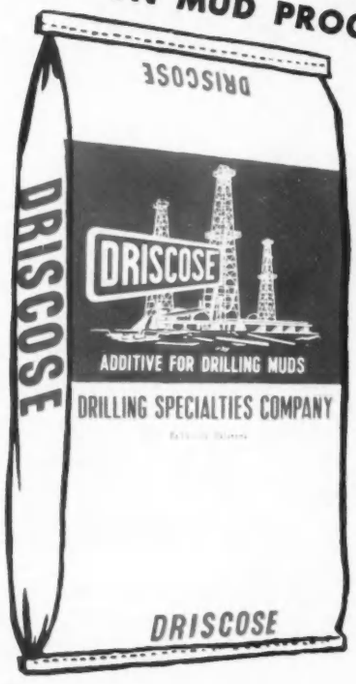

Two important ways in which low pH, low solid Driscose emulsion muds save money are (1) Decreased number of bits (2) Increased penetration rate. You get excellent weight suspension with good viscosity and gel characteristics. Less weighting materials and less cement are required because Driscose helps keep holes close to bit gauge. Driscose requires no special handling. It is soluble in hot or cold water. Order Driscose from your regular mud dealer in 50-pound, water-resistant bags.

*Driscose is a trademark for 99.9% pure Sodium Carboxymethylcellulose.

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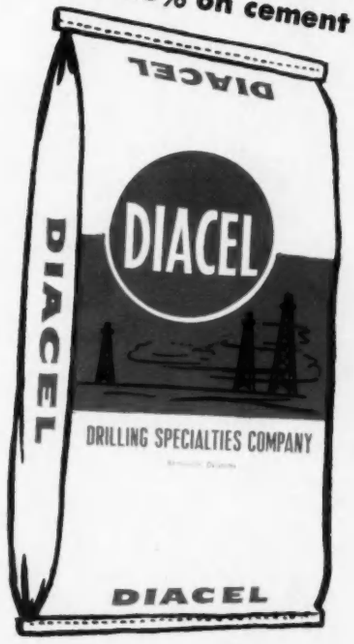

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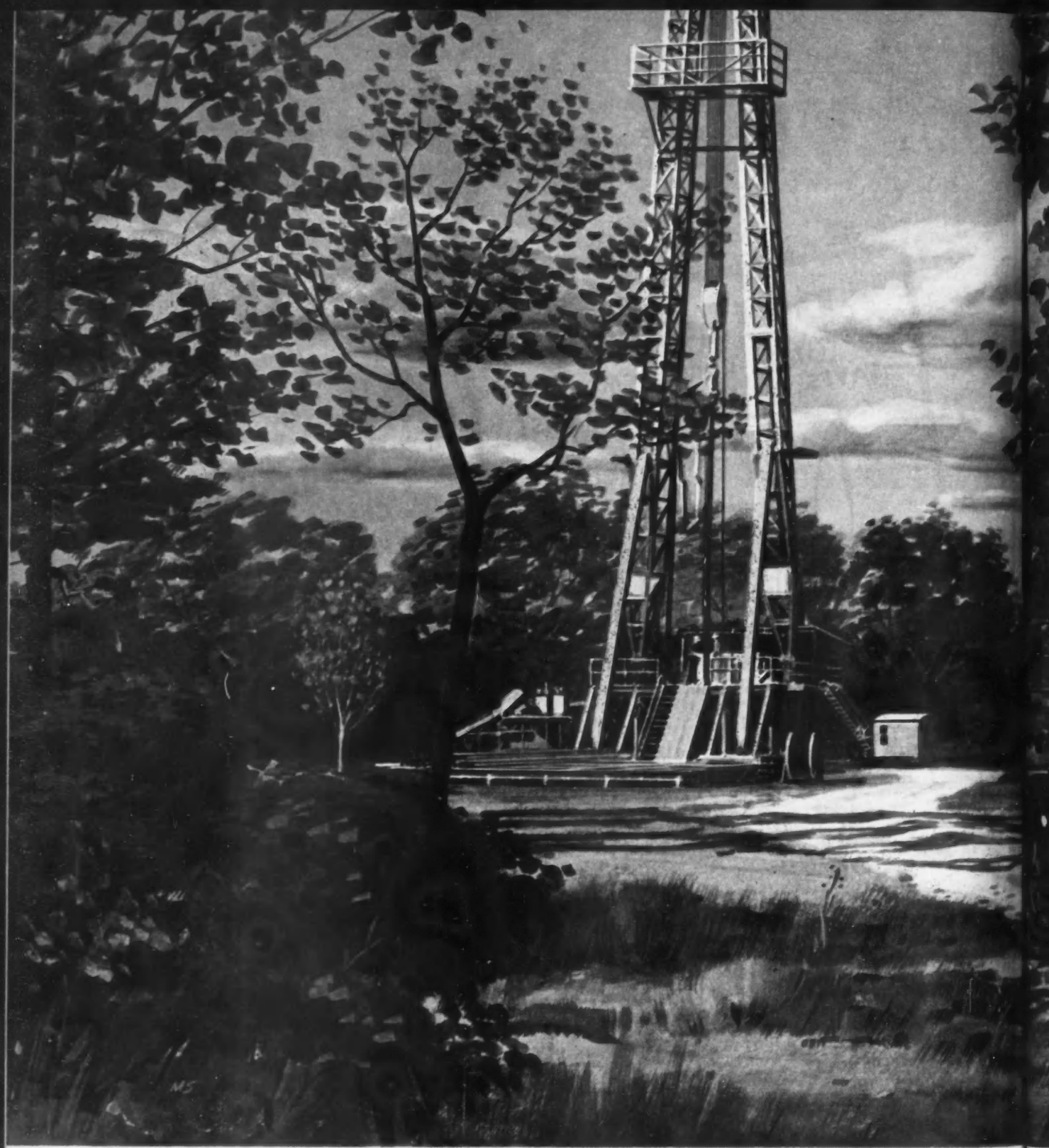
Bartlesville, Oklahoma



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SCHLUMBERGER **FIRST IN THE FIELD—FOREMOST IN RESEARCH**

WELL SURVEYING CORPORATION

Schlumberger... to be sure !

Reserve rope	3666 feet
Service interval between cuts in ton-miles	1500
Total service expected—based on 11 ton-miles/feet	55,000

Therefore, length to cut is 3666 × 1500/55,000, or 100 feet. The length was adjusted to 98 feet as this equalled 11½ drum wraps. Pick-up initially made with 10 wraps with one slip of a wrap and a half, halfway between drum cuts. Despite the fact that only one of the values in the above equation is fixed (length purchased), the other values can be reasonably estimated and with experience the values can be determined within fairly accurate limits. By transposing the equation each value can be determined where the other values are known.

That is:

$$\text{If length of cut} = \frac{\text{Length of reserve} \times \text{Service Intervals}}{\text{Total ton-mile service expected}} = L_c = \frac{L_r \times TM_i}{TM_t}$$

Then

$$\text{Ton-Mile Total} = TM_t = \frac{L_r \times TM_i}{L_c}$$

$$\text{Service Interval between Cuts} = TM_i = \frac{L_c \times TM_t}{L_r}$$

$$\text{Length of Reserve Rope} = L_r = \frac{L_c \times TM_t}{TM_i}$$

Figure 2 offers a ready solution to the four equations. In using the chart, the known values of the numerator and denominator of the first term of the equation are connected, crossing the diagonal line *AB* at some point *C;* this point is connected with the known value of the other term of the equation and continued through point *C*. The desired answer is then read on one of the horizontal or vertical scales. For example, solving equation (1) above, the known values of the first term of the equation are connected together; that is, a line is drawn, connecting 3666 on the L_r scale with that of 56,000 on the TM_t scale, intersecting the diagonal line *AB* at the point *C*. A line is then drawn from the value of 1500 on the TM_i scale through the intersection point C and continued through to the L_c scale, which is found to read 98 feet.

The chart can be worked forward, backward and sideways if it is desired to toy around with probable, or even improbable, lengths of cut and service intervals between cuts. One of the main values of the chart is that it will show the absolute fallacy of making short cuts of random lengths at irregular intervals of service. In the above example, if the length of cut is reduced to 60 feet and all other values unchanged—the indicated total ton-miles would be in excess of 90,000, an improbable total. Likewise, if the service interval between cuts is increased to 2400 ton-miles, with all other values unchanged, the total would again approximate 90,000 ton-miles. Again, however, due to the service interval being too great for the length of cut, one or several long cuts would have to be made in order to remove worn out rope from the string up.

The value of a controlled rotary drill line cutoff program will be realized by referring to the string-up diagram. With 8 lines reeved through the blocks and drill pipe stands averaging 93 feet in length, each time a stand is hoisted a total of 8 × 93 feet or 744 feet of rope is wound on the drum. This 744 feet added to the 85 feet of dead rope on the drum reflects the 829 feet receiving the greatest wear and abuse. This amount divided by the length of cut (98 feet), equals 8½ cuts. The ton-mile service interval between cuts averaging 1500 ton miles means approximately 12,500 ton-miles accumulated on the line before successive cuts moved this portion of the line out of the system. The above is not intended to mean that a designed or controlled program should eliminate the need of visual inspection by the toolpusher or drillers. It is intended as a guide in obtaining maximum economic service from each line.

The table at the left will also serve as a guide in starting a controlled program. It will be seen that for a given length cut the service interval between cuts varies with the diameter of the rope, the size of equipment, and the type of drilling. Where rates of bit penetration are slow, the lines suffer a greater amount of fatigue than when drilling rates are fast with the lines in motion as the rope is fed off the drum.

Another value of the string-up diagram is that most causes of wire rope trouble can be traced to the source, provided an accurate record of the cuts is maintained. This can usually serve as a running inventory of reserve rope remaining by determining the reserve rope when installed and subtracting the length of each cut from this amount.

The minimum economic length is

Table or Guide for Determining a Controlled Rotary Drill Line Cutoff Program

1⅝-INCH DIAMETER ROPE—5000 FEET.
136 Foot Derrick, 8 Lines, 48-Inch Diameter Sheaves. Grooved Drum
Reeving Length = 1300 Feet, Reserve Rope = 3700 Feet
Length of Cut = Approximately 100 Feet

Drum Diameter	Ratio of Drum to Rope Dia.	Reduction in Drum Dia. Percent	RECOMMEND: Rock Bit Drilling — Service Interval	Rock Bit Drilling — Total Service Estimated	Drag Bit or Gulf Coast — Service Interval	Drag Bit or Gulf Coast — Total Service Estimated
36	26.2	100%	2,000	74,000	2,200	80,000
34	24.7	94%	1,900	70,000	2,100	77,500
33	24.0	92%	1,850	68,500	2,000	74,000
32	23.3	89%	1,800	66,500	1,950	72,000
30	21.8	83%	1,650	61,000	1,800	66,500

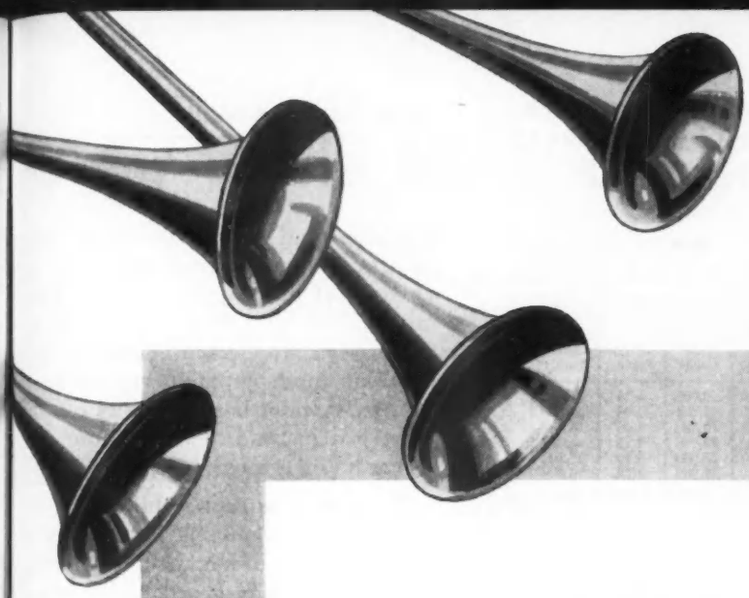
1¼-INCH DIAMETER ROPE–5000 FEET
136 Foot Derrick, 8 Lines, 48-Inch Diameter Sheaves. Grooved Drum
Reeving Length = 1300 Feet, Reserve Rope = 3700 Feet
Length of Cut = Approximately 100 Feet

32	25.6	100%	1,600	60,000	1,800	66,000
30	24.0	94%	1,500	56,000	1,700	63,000
28	22.4	87.5%	1,400	52,000	1,550	57,500
26	20.8	81%	1,300	48,900	1,450	53,500
24	19.2	75%	1,200	44,000	1,300	48,000

1⅛-INCH DIAMETER ROPE—3500 FEET
133-Foot Mast—8 Lines, 42-Inch Diameter Sheaves. Grooved Drum
Reeving Length = 1250 Feet. Reserve Rope = 2250 Feet
Length of Cut = Approximately 90 Feet

30	26.7	100%	1,400	35,000	1,600	40,000
28	24.9	94%	1,300	32,500	1,400	35,000
26	23.1	87%	1,200	30,000	1,300	32,500
24	21.3	80%	1,100	27,500	1,200	30,000
22	19.6	73%	1,000	25,000	1,100	27,500
20	17.8	67%	900	22,500	1,000	25,000
18	16.0	60%	800	20,000	900	22,500
16	14.2	53%	700	17,500	800	20,000

Note: All figures listed above are based upon ropes of Preformed, Seale Construction, Improved Plow Steel with Independent Wire Rope Core.



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the length required to string up plus the length wound on the drum in hoisting a drill pipe stand plus the dead rope on the drum at the pick up point. Or in this example:

Length required to string 8 lines	1334 feet
Rope wound on drum each hoist cycle (8 x 93)	744 feet
Dead rope on drum at pick up plus one 13-foot slip	98 feet
	2176 feet

We are all conscious of safety, but too much reference to design factors and factors of safety is confusing unless this information can be readily converted into safe hook loads for various rope sizes and the number of lines strung through the blocks.

It was stated earlier that the definition of design factor was the breaking strength of the rope divided by the load per line. In practice it would be well to define design factor as the breaking strength of the rope divided by the heaviest loaded line which is the drum line. This is due to the loss in efficiency caused by sheaves bearing friction and the rope bending around the sheaves which runs approximately 2 percent per sheave and for an 8-line string-up would be .841.

The maximum load on the drum line can be determined from the following formula:

$$P = \frac{W}{NE}$$

Where P is load on drum line in lbs.
W is hook load, including traveling block and hook assembly
N is number of lines strung through the blocks
E is efficiency factor

Substituting average field values in the above equation—allowing 25,000 pounds for block and hook assembly weight, but not including excess weight of any drill collars. Using 10,000 feet of 4½-inch 16.6 pound/foot drill pipe with tool joints and correcting for the buoyant effect of 75 pound per cubic foot or 10 pounds per gallon mud and 8 lines strung.

$$\text{Then } P = \frac{175{,}000}{8 \times .841} = \frac{175{,}000}{6.728} = 26{,}000 \text{ lbs.}$$

Using 1¼-inch 6 x 9 Seale, improved plow steel, IWRC line, with a breaking strength of 139,000 pounds, the design factor would equal

$$\frac{139{,}000}{26{,}000} \text{ or } 5.35.$$

Under the conditions listed above, Table 1 will reflect hook loads and design factors for 8 and 10 line string-ups and depths from 10,000 to 15,000 feet.

TABLE 1

Depth in Feet	Hook Load in Lbs.	8 LINES		10 LINES	
		Fast Line Loads	Design Factor	Fast Line Loads	Design Factor
10,000	175,000	26,000	5.35	21,600	6.44
11,000	190,000	28,300	4.90	23,400	5.94
12,000	205,000	30,500	4.55	25,300	5.50
13,000	220,000	32,700	4.25	27,200	5.10
14,000	235,000	35,000	3.98	29,100	4.78
15,000	250,000	37,200	3.72	30,800	4.50

In Table 1 it will be noted that hook loads only have been considered without regard for hook speed. The following horsepower equations will accurately indicate the amount of work performed by a rotary drill line in service, and the possible heavy shock loading the lines are often subjected to in starting and braking the hook loads.

To determine input horsepower to the hook where hook load and hoisting speed are known:

$$\text{Horsepower} = \frac{\text{Hook Speed} \times \text{Hook Load}}{33{,}000}$$

$$\text{Hook Speed} = \frac{\text{Horsepower} \times 33{,}000}{\text{Hook Weight}}$$

$$\text{Hook Weight} = \frac{\text{Horsepower} \times 33{,}000}{\text{Hook Speed}}$$

From the above table and the horsepower equation, it will be seen that in order to maintain an off-bottom hoisting speed of 100 feet per minute from 10,000 feet with a hook load of 175,000 pounds the hook horsepower will be equal to 100 × 175,000/33,000 = 530 hp.

Since transmission efficiencies from rated engine output horsepower through engine compound, drawworks transmission and the reeving system to the hook seldom exceeds 50 percent, the actual input rated horsepower required will be 530/.50 = 1060 hp.

From this it will also follow that if the above load is lowered into the hole only 5 times as fast as it was hoisted, the energy absorbed will be 5 times the hook horsepower required in the hoisting operation, or approximately 2500 hp.

The above will also serve in part to explain the wide difference in rope service between rigs of the same size operating under very similar conditions. —**The End**

New Emulsion Muds

Continued from Page 156

emulsion mud prepared with 50 percent by volume of fresh water has a viscosity of 57 centipoises and a ten-minute gel strength of 2 grams, whereas in the second example the emulsion mud prepared with 60 percent fresh water has a viscosity of 115 centipoises and a ten-minute gel strength of 7 grams.

Table 6 also shows the results of converting the oil base mud to a water-in-oil emulsion. In the example shown, conversion is accomplished by adding 20 percent diesel oil, two pounds per barrel of peptizer *A*, four pounds per barrel of calcium chloride, and 80 percent fresh water to the oil base mud. Addition of the diesel oil was necessary prior to conversion to prevent the viscosity of the resulting emulsion from becoming excessive.

The water-in-oil emulsion, like the oil base mud, can be weighted to 17 pounds per gallon by addition of barite.

Applications. The following may be used as a guide in determining the proper use of these new drilling fluids:

As an Oil Base Mud

Native state coring
Completion and workover fluid
High temperature applications
Perforating fluid

As a Water-in-Oil Emulsion Mud

Completion and workover fluid
Drilling long sections of hole
Perforating fluid

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This paper was presented at the Sixteenth Annual Meeting of the American Association of Oilwell Drilling Contractors, Fort Worth, Texas, October 7-9, 1956.

Your Well's Minimum Rate of Flow

A petroleum engineer with the Railroad Commission reviews the techniques of conducting minimum flow rate tests.

By G. P. COKINOS
Texas Railroad Commission
Beaumont, Texas

"My well is producing 62 barrels of oil with 186 barrels of salt water per day. Under these conditions I can not possibly shut the well in to comply with the Texas Railroad Commission shutdown requirements. If I shut the well in or attempt to produce within the allowable, it may die."

THIS IS THE general text of many of the letters and telephone calls received by the Engineering department of the Oil and Gas division of the Texas Railroad Commission.

The operator is requesting relief for the well either in the nature of an allowable increase or an order to remove the well from shutdown requirements made by the commission each month.

As soon as the Railroad Commission is notified by the operator that the well is in danger of going "dead," because of the proration restrictions, a hearing date is set on the Commission docket in Austin. The commission's engineer in the field is notified

A COSTLY LESSON IN CONSERVATION

COULD THIS HAPPEN TO YOU? READING THIS ARTICLE MIGHT HELP TO PREVENT IT.

A lesson in the study of chokes was learned the hard way by a Gulf Coast operator recently on a well to which a Commission engineer was called to conduct a minimum flow rate test. The purpose of the test was to determine whether waste would occur if the well was not granted a special allowable. The operator contended that the well could die in a few days if the current allowable of 120 barrels a day was not exempt from shutdown days.

The minimum flow rate tests were started at the rate that the operator produced the well—255 barrels of oil per day—135 barrels over the allowable. The choke size stamped on the choke indicated it to be a 28/64-inch choke.

A series of choke changes was gradually made until the well's minimum rate of flow was established at 60 barrels of oil a day through 18/64-inch choke. The salt water percentage was checked at 85 percent.

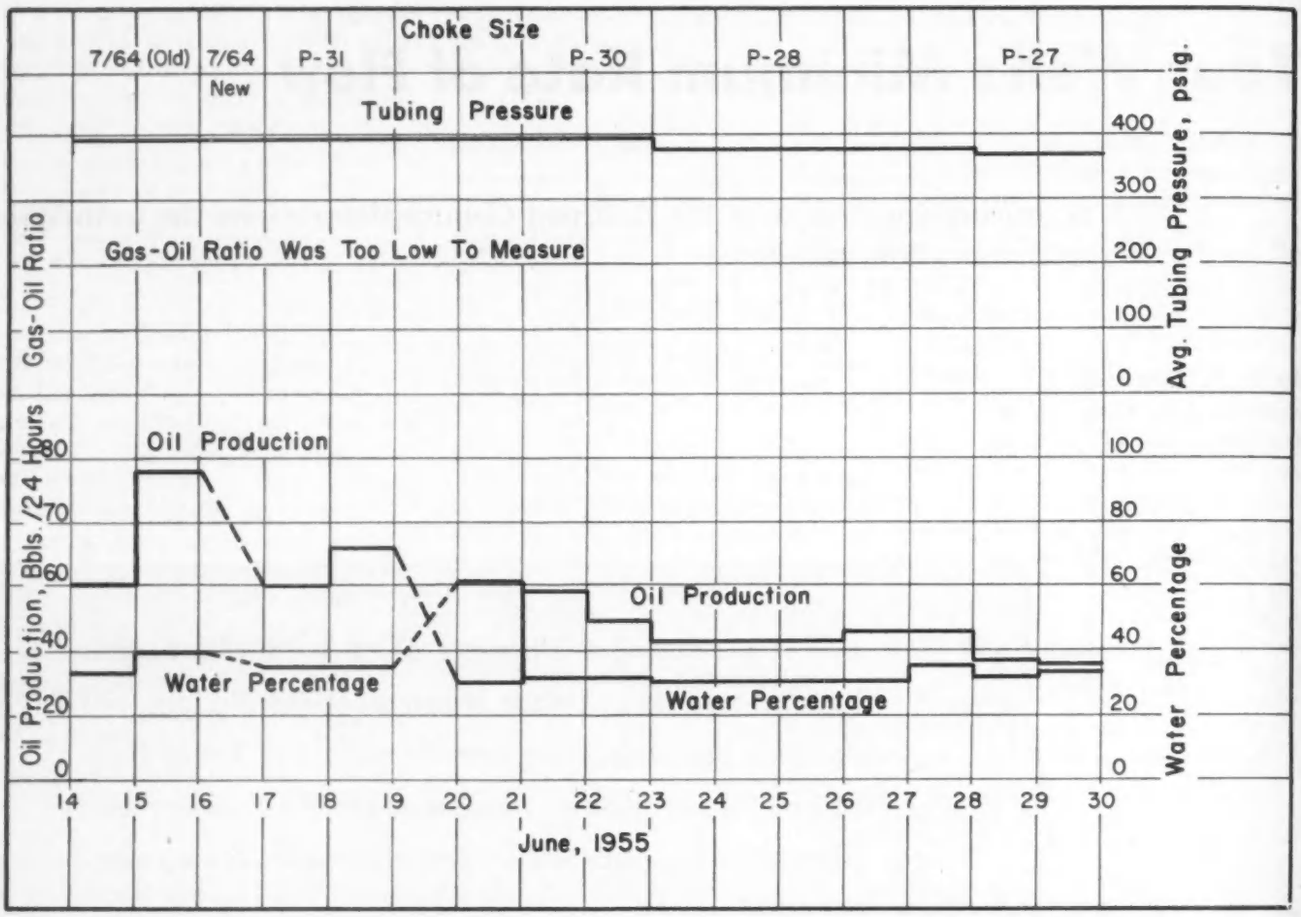
Originally the well produced its calendar allowable through a 1/8-inch choke with a 10 percent salt water yield.

The operator learned too late that the lease man in charge of the well was not in any sense disciplined in the use of chokes.

Several weeks previously the lease man had inadvertently gotten over 1000 barrels behind. The pipe line gager informed him of the underproduction with only three days left till the end of the month.

The well was put on a 1/4-inch choke and the underproduction was made up in a short time. During the process the salt water production jumped to the 85 percent figure where it remained. The rest of the story can be filled in quickly. The salt water frightened the lease man and he became involved in the vicious circle of enlarging the choke size to increase production only to be deluged by more salt water. The circle ended with the operator calling the Railroad Commission for relief as mentioned above.

P. S. The lease man lost his job but the operator lost thousands of barrels of oil through the encroachment of salt water which occurred much sooner than had been anticipated by his reservoir engineer.



This graphic illustration was made from the data on the tabular form for presentation at the hearing in Austin. The results are more easily compared in this manner since all of the factors are more readily seen as a continuity.

of the pending hearing and the wheels are set in motion for the accumulation of production data which will be presented at the hearing. These data are acquired through "minimum rate of flow" tests ordered by the Railroad Commission.

What is Minimum Rate of Flow. The minimum rate of flow of a well is that rate of flow preceding the rate at which the well shows definite signs of "loading up" and the tubing pressure establishing a trend downward.

Procedures for minimum rate of flow tests vary depending upon whether the well is flowing, pumping or produced by gas lift.

When making the initial inspection for minimum flow rate tests, a 24-hour production test should be made on the well just as the operator has been producing it. This test provides all the necessary data on oil and water production, gas-oil ratio, oil gravity and the recorded tubing pressure of the well. It is also highly important that the choke is inspected and calipered for correct size.

Cut Chokes. In many cases it has been found that the choke has been cut-out to a greater size than it was originally. It becomes necessary, consequently, to place in the choke chamber, for the ensuing 24-hour testing period, a new choke of the exact size to which the old choke was cut. As a result, the well is produced and tested through a choke of known size. Any further reductions in choke size have

Tabulated Results of a Minimum Rate of Flow Test

Date of Test	Choke	Tubing Pressure	Oil/24 Hours	Percent Water
June 14-15	7/64 (old)	395	60.72	33
15-16	7/64 (old)	395	78.10	39
16-17	7/65 (new)	395	(incorrect gages)	
17-18	P-31	395	60.00	35
18-19	P-31	395	66.00	35
19-20	production test void since pipe line gager sealed the valve open and oil production went into pipe line			
20-21	P-31	395	30.40	Error, See Chart
21-22	P-30	380	59.00	32
22-23	P-30	380	49.50	33
23-24	P-28	375	42.00	30
	(Choke jumped from P-30 to P-28 since a P-29 was not available)			
24-25	P-28	375	42.00	30
25-26	P-28	375	43.50	30
	(The well is definitely showing a trend of stabilization)			
26-27	P-28	375	45.00	30
27-28	P-28	375	45.00	35
28-29	P-27	370	37.20	32
29-30	P-27	370	36.00	33

(Tests concluded at this point since the calendar day allowable is 35 barrels per day)

The calendar day allowable of this well was 35 barrels per day. When first inspected it was producing 60 to 78 barrels per day. The tabular data on the minimum rate of flow test shows that the rate of flow was decreased from 78 to 36 barrels per day. This was accomplished without any apparent damage to the flowing characteristics of the well. This indicates that it should be able to produce within its calendar day allowable.

a definite starting point and testing plans can be made methodically.

Choke Discipline. At this stage of the minimum rate of flow test it is well to point out the importance of the choke to the operator. The value of his realizing the importance of the proper use of chokes in a producing well cannot be over emphasized.

When the engineer in charge of the test has familiarized himself with the past producing performance of the well, the program of the tests take shape. It is up to those directly in charge of the tests to determine to what extent the rate of flow can be reduced to obtain a minimum rate of flow. Extreme caution must be exercised when decreasing the choke to make the changes gradually. Sufficient time should be allowed between changes for the well to stabilize on each new choke reduction.

Generally, a well producing from thin impermeable sands will require several days for stabilization while a well with thick sands of high permeability require only a short time for stabilization.

Insert chokes or "button" type chokes that are graduated to increase or decrease by 5 to 10 percent are best for the purpose of a minimum rate of flow test.

Choke Reduction. Choke size reductions or increases should be gradual—gradual being not over 1/64 inch at each change.

In the production of salt water, if it is in a small percentage, the water production often will disappear if the choke is reduced slightly. However, the regrettable thing is that after the choke reduction the oil production also decreases. Toward the end of the month the operator finds the production is behind, and the temptation is great for the operator to increase the choke size in order to make the allowable before the month is up.

This is risky business, because, first the choke will probably be an increase of several sixty-fourths over the one normally used, which in itself is not conforming to good production practice. Second, with the rate increasing, the prospect of more salt water production is high.

Once the choke is increased for the purpose of making up back production the vicious circle begins. More salt water is indicated in the shakeouts.

Generally, if the perforated interval is above the oil-water contact, the salt water production will decrease as the choke size is reduced, but if the sand is perforated below the oil-water contact, the percent salt water will increase as the choke size is decreased.

If the well-head or tubing pressure had been charted on a 24-hour recorder, a comparison could be made between pressure behavior and oil and water production.

About the Author

GENIOS PETE COKINOS, senior petroleum engineer with the Oil and Gas Division of the Texas Railroad Commission, is a petroleum engineering graduate of Texas A. & M. College. A native of Beaumont, Texas, his first oil field work was in drilling and production with the Stanolind Oil & Gas Company at Spindle Top dome. After graduation from Texas A. & M. he joined Hamman Oil & Refining Company. He joined the Texas Railroad Commission in Corpus Christi, Texas, shortly before World War II. After serving two years in the Air Force, he rejoined the Railroad Commission as engineering representative in the Upper Gulf Coast-Beaumont area. Cokinos is a registered professional engineer, a member of the Beaumont Spindle Top Section of the A.I.M.E., member of the American Association of Petroleum Geologists.

As time goes on and the well runs the normal course of events, "choke discipline" becomes more important.

Test Data. Production test data, necessary for the hearing, should be kept on each 24-hour test. During each of the test periods an attempt is made to progressively decrease the rate of flow to a rate producing the equivalent of the calendar day allowable.

The calendar day allowable is calculated through a simple arithmetical process as follows:

$$\text{Allowable/Day} \times \frac{\text{Number of Producing Days}}{\text{Number of Days in Month}}$$

Allowable. When a well is initially completed and turned into the tanks for production, the lease man is given the task of making the 7 a.m. gage each day with instructions from the operator to produce the well within its allowable.

The thought that the work is over with the well turned into the tank may be true, but just in part. Now a new task is in the making—the task of producing the well within its allowable and in a manner conducive of good, sound conservation practice.

The operator is given the option of either abiding by the shutdown day restriction or producing the well at a calendar day rate for each day of the month. The latter is generally preferred by most operators and oil companies.

After the allowable for the new completion has been obtained and the 30-day G-O 2 filed with the commission, a complete file of the pertinent data should be made on the well. This includes electric logs and any core analysis; productivity index buildup and interference tests; the perforated interval corrected for depth control; drill stem tests with special emphasis on any block squeeze completions either at the oil-water or gas-oil contacts.

Tubing Recorders. The tubing pressure should be recorded on a 24-hour pressure recorder and the charts made available at the hearing. The success of the minimum flow rate tests depend upon the interpretation of the

tubing pressure behavior as recorded.

The complete production data of the test and the 24-hour tubing pressure behavior of the well can be noted and compared. In cases where signs indicate that the well is going dead, choke increases must be made in time to unload the well and revive the tubing pressure.

If the well does not have a packer in the casing annulus, a 24-hour pressure recorder should be connected to the casing. The casing pressure will reflect loading of the annulus and indicate an early sign of declining tubing pressure.

Since the success of the test is dependent upon the interpretation of the tubing pressure 24-hour charts, it should be pointed out that the judgment of engineers conducting the minimum flow rate tests is very important. It is no place for a novice or one inexperienced in the ways of handling producing wells.

In the study of the tubing charts any irregularity in the well flow is significant and if any wide fluctuations occur, caution must be exercised and the well put under a 24-hour surveillance.

Salt Water. The detection of a well beginning to produce salt water is generally discovered by the pipeline gager running a tank of oil. This becomes known to the gager through the standard operating procedure of "thiefing" the tank and taking several shakeouts.

In conducting the minimum rate of flow tests, the salt water produced on a 24-hour test is determined by any of the standard methods—by shakeouts, gun-barrel gaging with water-finding paste, or by the actual gage of total fluid.

Example. Here is an example of a minimum flow rate test recently made on a well in the Phoenix Lake field, Orange County, Texas.

An allowable increase was requested by the operator of a well producing from the 7900-foot sand. The allowable increase request was made in the form of asking for an increase in the gas limit of the oil well. The gas limit for the well was 114 barrels per day × 2000 cubic feet of gas per barrel per day equaling 280,000 cubic feet of gas per day. There were no shutdown day restrictions to consider since the eastern part of the field extends across the Sabine River into Louisiana which has no shutdown day requirements.

Upon initial inspection, prior to beginning the minimum rate of flow tests, the well was tested and yielded 46.68 barrels of oil plus 910,000 cubic feet of gas on a 24-hour test. The choke size was 14/64-inch with a tubing pressure of 1250 pounds per square inch and the well produced 88 percent salt water.

This amount of production from the reservoir daily was far in excess of the fluid withdrawal allowed by the Commission. This more than tripled the figure produced by the offset operators in the same sand. But the operator's contention was that this rate of production was necessary to keep the well unloaded and flowing.

The minimum rate of flow test commenced. Through the process of gradually reducing the choke sizes, the well was found to have a minimum rate of flow established at a daily rate of oil production at 21.39 barrels through a 1/8-inch choke with a tubing pressure of 1325 pounds per square inch with a salt water percentage of 84 percent. Through the minimum rate of flow test the well performance indicated it could be produced at a lower rate with a marked improvement of wellhead pressure and a lesser amount of salt water. It proved that the operator was producing the well at a much higher rate than was desirable or necessary.

Pumping Wells and Gas-Lift Wells. Minimum flow rate tests can be applied to pumping and gas-lift wells as well as flowing wells. With pumping wells the minimum production tests should commence at the rate that produces the minimum amount of water. The strokes per minute and length of stroke can be reduced to obtain the minimum rate of production.

With gas-lift wells the same procedure should be followed with the reduction in production coming from the decrease in the amount of gas used for injection.

Minimum flow rate tests for any type of well being produced by artificial or lift methods is generally the exception rather than the rule.

Conclusions. The job of the petroleum engineers with the Texas Railroad Commission is to help the operators produce their wells without waste. This is an effort in the interest of conservation for the protection of the public welfare.

If it is proven that waste will occur when an operator has to produce a well within stated limits, then the necessary steps are taken to alleviate this condition. By the same token when engineering data proves the limits are necessary and justified for proper conservation, they will be maintained. The result contributes to an effective proration program fair to the people of the State of Texas and the operator.

Here is a recap and a few conclusions relative to production in general and minimum rate of flow tests in particular.

1. Exercise care in choosing a choke size.

2. Make accurate oil and water gages using a water-finding paste if possible.

3. Use tubing recording pressure gages which will provide a play-by-play performance of the pressure readings.

4. Use the normal gas reading devices so that a gas-oil ratio trend can be established.

5. Inspect the choke chamber and caliper the choke at least once a week.

6. A small choke change may mean as much as a 10 percent difference in fluid withdrawal from the reservoir.

7. When gas lift is anticipated, install gas lift valves during regular work over to avoid pulling tubing solely for this purpose if possible.

8. Keep a complete record of production and well information from the first log to today's shakeout. It can help the engineers of the Oil and Gas division of the Texas Railroad Commission help you.

ACKNOWLEDGMENT

The author acknowledges the assistance of Arthur Barbeck, chief engineer for the Texas Railroad Commission, in obtaining some of the data used.

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Solve Your Own Pump and Rod Problems

This is the first of a two-part article covering the basic applications of production equipment. This part on pumps and rods will be followed next month by a discussion of unit pumpers and prime movers. The methods and formulae presented here are those proven easy to use, reasonable and well-founded, and safe for average pumping problems. Many variations from these procedures are practiced by specialists in application of production equipment—and with good reasoning and proof to back up their use. This presentation is not intended to provoke argument, but rather to provide a sound application technique for use by experienced personnel on which they can build as experiences and observations warrant.

Here are the basic calculations necessary for the selection of a proper bottom hole pump and sucker rod string. Both the beginner and the experienced hand will find them useful.

By TOM H. FRASER
Continental Supply Company
Dallas

The selection of the bottom-hole pump size and type is of utmost importance because the sizes and capacities of all other items of pumping equipment depend solely on the bore of the pump, the stroke length, and the strokes per minute necessary to secure the desired production. In general, the bottom-hole pump selected should be of the smallest bore that will secure the desired production, at reasonable length of polished rod stroke and strokes per minute. Proper selection will result in lighter polished rod loads, less torque requirements, and better counterbalancing. In selecting the length of stroke and strokes per minute, reference should be made to the pumping curves shown in Figures 1A and 1B, and to data giving polished rod stroke lengths of the size pumping unit guessed to be applicable to the well in question.

After arriving at a tentative polished rod stroke, strokes per minute, and plunger diameter, calculation should be made on the volume of fluid to be secured under those operating conditions. For aid in this calculation, refer to the following table which presents pump constants applicable to the bore of the pump under consideration.

TABLE OF PUMP CONSTANTS

¾ inch	= .066
1 inch	= .117
1 1/16 inches	= .132
1¼ inches	= .182
1½ inches	= .262
1¾ inches	= .357
1 25/32 inches	= .370
2 inches	= .466
2¼ inches	= .590
2½ inches	= .729
2¾ inches	= .881
3¾ inches	= 1.639
4¾ inches	= 2.630

To find the production in barrels per day at 100% pump efficiency, multiply the stroke length in inches times the strokes per minute times the pump constant or—

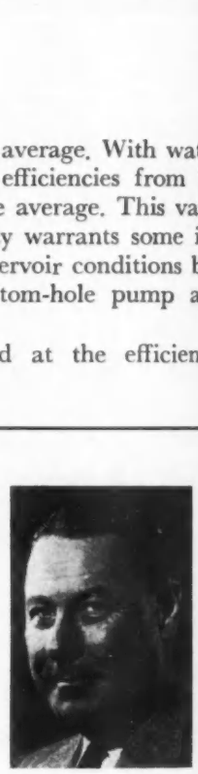
P = (Stroke) × (Strokes Per Minute) × (Constant)

This production figure is used in the calculations pertaining to the horsepower required in the prime mover.

The next step is to estimate the efficiency to be expected from the bottom-hole pump. This can only be done with some knowledge of the reservoir conditions, i.e.—will there be solution gas?—will there be water drive?—will there be sand troubles?—will water-flooding ever be applied?—and other considerations. With solution gas reservoirs, efficiencies between 40 and 60% are average. With water drive reservoirs, efficiencies from 75 to 95 percent are average. This variation in efficiency warrants some investigation of reservoir conditions before making bottom-hole pump applications.

Having arrived at the efficiency

Meet the Author



TOM H. FRASER has been for two years manager of the Production Equipment division for Continental Supply Company. In his 22 years for Continental he has worked with the Engineering department in Dallas, as a warehouseman, field salesman in East Texas, a city salesman in Tulsa and Fort Worth, and a district machinery salesman and district manager in north Texas. He received a B.S. in mechanical engineering from Texas A&M College and served a three-year stint as a captain in the U. S. Marine Corp.

figure to be expected from the bottom-hole pump, we now take our production volume, previously calculated, and modify it by the efficiency figure decided upon, thus:

Actual Production = Calculated Production × Efficiency

The decision as to the type of bottom-hole pump most applicable to the production reservoir in question can be decided only by specialists familiar with the recommendations and past experiences in handling production from this type reservoir. The application of the type of bottom-hole pump is practically a science in itself, therefore no attempt to make even general recommendations will be attempted. If the actual production, as calculated above, is greater than or less than that desired, then a re-calculation should be made either increasing or decreasing all, or any one, of the factors, as is indicated. This procedure will allow arrival at a definite plunger diameter, number of strokes per minute, and polished rod stroke necessary to secure the production volume desired.

Sucker Rods. The design of a sucker rod string is basically a matter of figuring various sizes and grades of sucker rods until a string is selected having the lightest actual weight, adequate load carrying capacity, acceptable rod stretch characteristics, and the least cost. The procedure is as follows: First, make a tentative selection of sucker rod size, basing your selection on the well depth and size of plunger. In certain wells the load on the sucker rods due to their own weight can be lowered by using tapered rod strings. When this is done, the proportions of each size should be those given in Table 1. This table of proportions is based upon securing equal static stress in the top rod of each step of the string.

Second, multiply the footage of each size of sucker rod by the weight per foot of that size rod to get the Rod Weight in Air. Use the following figures for weight per foot of the various sizes of sucker rods:

⅝ inches = 1.16 #/ft.
¾ inches = 1.63 #/ft.
⅞ inches = 2.16 #/ft.
1 inch = 2.85 #/ft.
1⅛ inches = 3.67 #/ft.

Next, find the Effective Weight of Rods by deducting ⅛ of the Rod Weight in Air just calculated. This ⅛ deduction compensates for the buoyant effect when the rods are hanging in tubing filled with liquid. This Effective Weight of the Rod String is used in all future calculations.

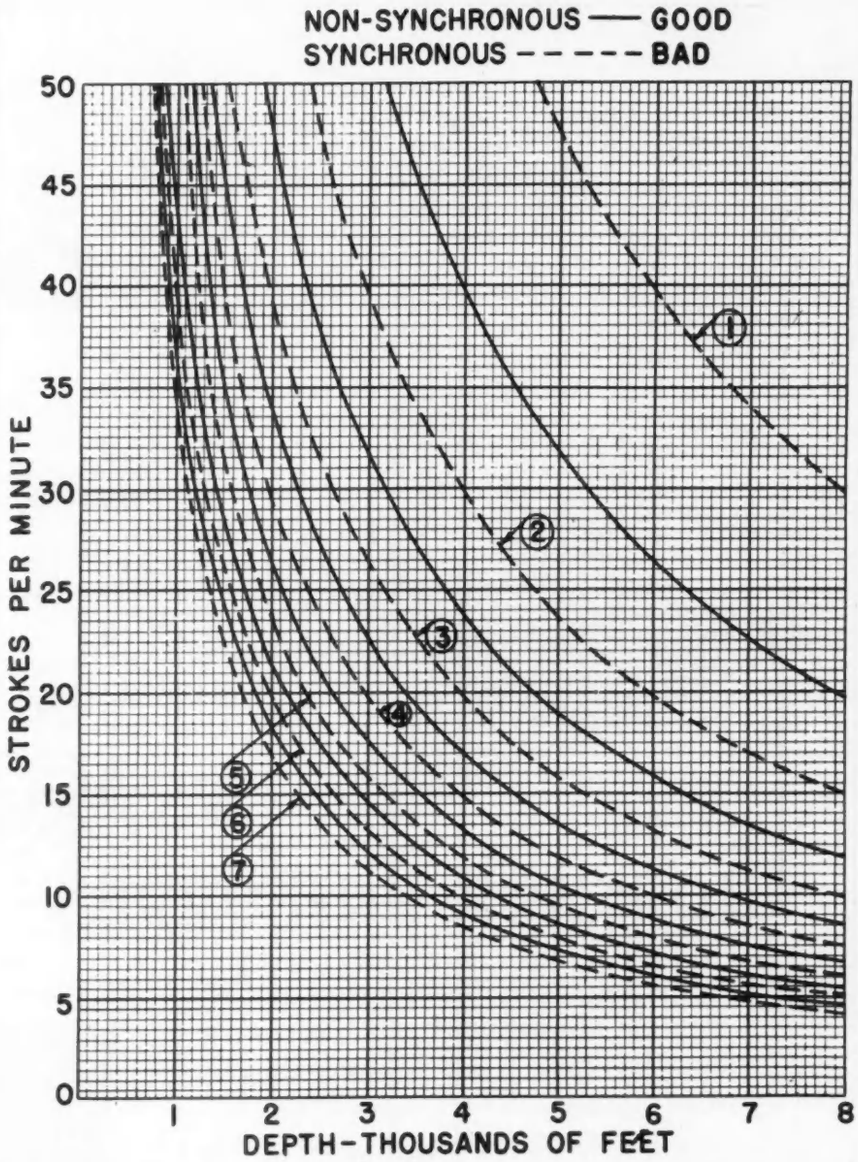


FIGURE 1A—This pumping speed curve chart may be used to determine desirable operating speeds for straight rod strings from 1000 to 8000 feet. (Turn page for Figure 1B.)

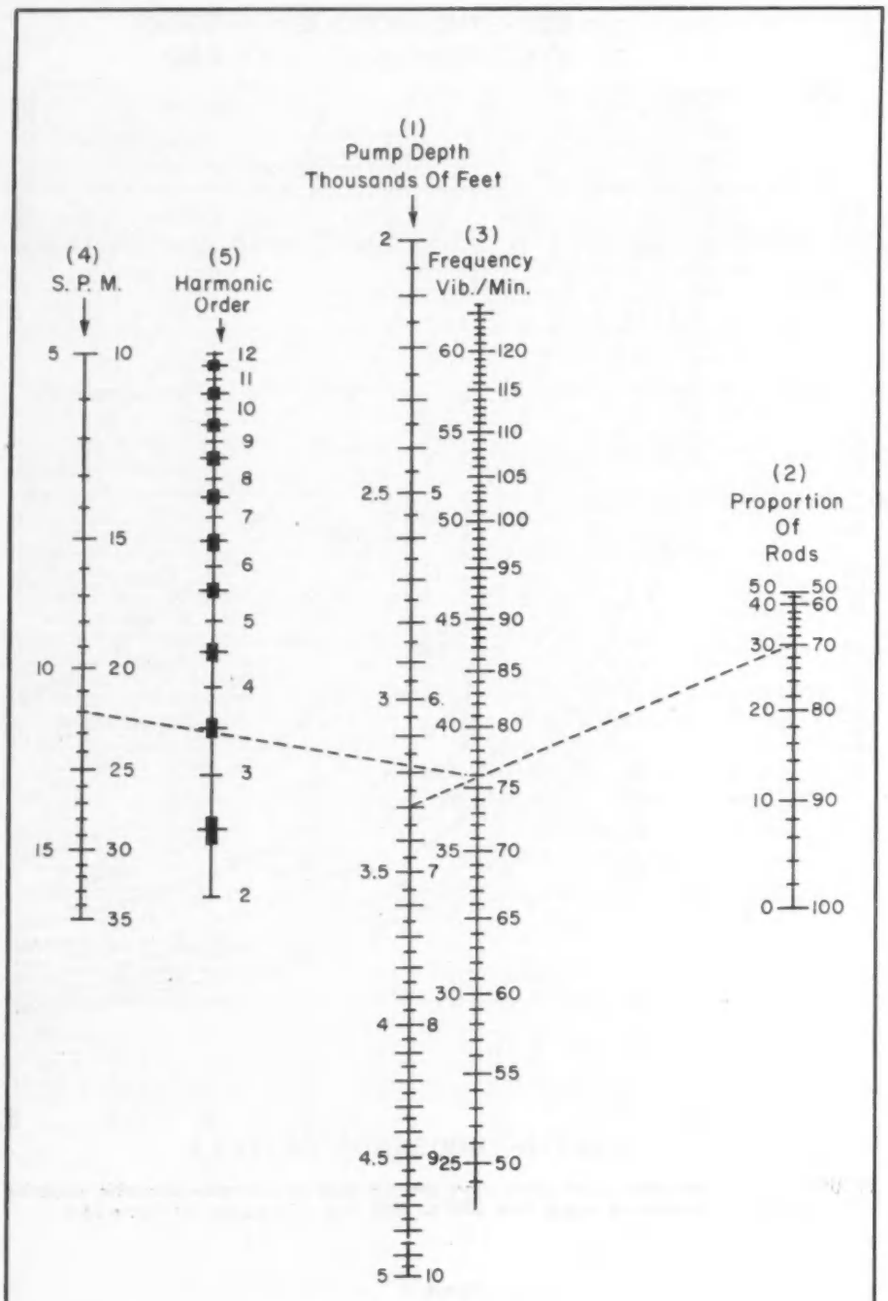
TABLE 1

Percentages for Tapered Rod Strings*

Plunger Diameter	THREE COMBINATIONS				TWO COMBINATIONS		
	1"—⅞"—¾"		⅞"—¾"—⅝"		1"—⅞"	⅞"—¾"	¾"—⅝"
	%¾"	%⅞"	%⅝"	%¾"	%⅞"	%¾"	%⅝"
1 1/16"	58.5	22.3	50.5	26.2	77.7	73.6	68.3
1¼"	55.4	23.9	45.7	28.7	76.4	71.7	65.2
1½"	50.5	26.4	38.2	32.7	74.3	68.6	60.4
1¾"	44.9	29.5	29.4	37.3	71.9	65.0	54.8
1 25/32"	44.0	29.9	28.1	38.0	71.6	64.5	54.0
2"	38.2	33.0	19.2	42.7	69.1	60.8	48.2
2¼"	30.8	36.9	7.6	48.8	66.0	56.1	40.8
2½"	22.5	41.3	....	....	62.5	50.8	32.6
2¾"	13.2	46.2	....	....	58.6	45.0	23.5
3¼"	....	....	....	....	49.7	31.6	....
3¾"	....	....	....	....	39.3	16.0	....

* Based on theory of equal stress at top of each step of string for static conditions.

Now to determine the Weight of the Fluid Column to be lifted by the plunger size of the pump selected earlier. This is calculated by multiplying the following weights per foot on



For best results: Maintain operating speeds that will allow the harmonic order to be within the shaded areas.

Note:

1. On Table 3, the higher frequencies are for wells from 2000 to 5000 feet deep, the lower frequencies are for wells from 5000 to 10,000 feet deep.
2. On Table 4, either the high or low SPM may be used—unless limited to low by the length of Polished Rod Travel.

Example:

Pump depth—3300 or 6600.
Rod string—30% 7/8" rods.
70% 3/4" rods.
Strokes per minute—22 for 3300; 11 for 6600.

Solution:

Lay straight edge from 3300 or 6600 (Col. 1) to 30% (Col. 2). Read frequency 75.9 for 3300 or 37.8 for 6600 (Col. 3), Pivot on 75.9 or 37.8 (Col. 3) to 22 SPM (Col. 4). Read harmonic order 3.45 (Col. 5).

FIGURE 1B—This nomograph is applicable for determining desirable operating speeds for straight and two way tapered rod strings from 2000 to 10,000 feet.

various plunger sizes by the depth of the pump setting.

3/4 inch plunger —	.191 #/ft.
1 inch plunger —	.340 #/ft.
1 1/16 inch plunger —	.383 #/ft.
1 1/4 inch plunger —	.531 #/ft.
1 1/2 inch plunger —	.765 #/ft.
1 3/4 inch plunger —	1.040 #/ft.
2 inch plunger —	1.360 #/ft.
2 1/4 inch plunger —	1.720 #/ft.
2 1/2 inch plunger —	2.120 #/ft.
2 3/4 inch plunger —	2.570 #/ft.
3 1/4 inch plunger —	3.590 #/ft.
3 3/4 inch plunger —	4.780 #/ft.
4 3/4 inch plunger —	7.690 #/ft.

Thus—Weight of Fluid equals Pump Depth times Weight Per Foot on plunger size selected.

The next step would be to add to the rod weight in order to compensate for the acceleration force of the rod string when it is in motion. This is done by referring to Table 2 to secure the factor applied to the rod weight; thus, the effective weight of the rod string, calculated previously, will be increased by the amount shown as the impulse factor. This weight can now be called the Dynamic Weight of the Rod String. Add this Dynamic Weight of the Rod String to the Weight of Fluid, as previously calculated. This total is called the Peak Polished Rod Load, and is the operating load to be imposed by the pump and rod string selected. Be sure that the Peak Polished Rod Load is within the allowable load limit for the size and type of sucker rods selected. If this loading is within proper limits, then the rod string is properly designed. If it exceeds the allowable load limit, then either use a better grade of sucker rods or increase the size of the sucker rods. When the latter is done, another complete sucker rod application must be calculated, due to the increased weight of the larger sizes of sucker rods. There are two ways to check the allowable load limit on sucker rods.

First—sucker rod manufacturers give recommended maximum loads for their various sizes and grades of rods. This Recommended Load can be checked directly against the Calculated Load, and if the Calculated Load is less than the Recommended Maximum, then the application is correct. Second—determine the pounds ped square inch stress that the Calculated Polished Rod Load would impose on the sucker rods selected by dividing the Calculated Peak Polished Rod Load by the area in square inches of the sucker rod. The area of

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sucker rods is as follows:

⅝ inch = .307 square inch
¾ inch = .442 square inch
⅞ inch = .601 square inch
1 inch = .785 square inch
1⅛ inch = .994 square inch

Thus—Stress = Peak Polished Rod Load divided by Rod Area.

Most rod manufacturers have about four grades of sucker rods, and that the allowable stresses will range from about 28,000 psi to 44,000 psi. By checking the calculated stress against manufacturers' allowable stress, it is possible to determine if the rod string is correctly designed.

It must be emphasized that the calculations apply to average well conditions. If a well is extremely deep, or must be pumped extremely fast, or if an extremely large fluid volume is desired, then the previous recommendations should not be followed. The application of production equipment for these unusual conditions is a problem for either a good engineer or a good equipment man of long experience and background.

Note that no calculations were made for the stretch of the sucker rod string. This was omitted in order to keep the calculations simple. Stretch calculations are not simple. The sizes of rods in the rod string, the proportions of sizes in the rod string, and the size of the plunger diameter all must be considered in calculating stretch. Ordinary applications to approximately 6500 feet will not have too much rod stretch if previous instructions have been followed and the smallest plunger diameter has been selected. Consideration can be given to the stretch factor when selecting an efficiency figure for the bottom hole pump capacity by decreasing the expected efficiency about 10 or 15 percent on shallow wells with small plungers to a maximum of about 40 percent on deep wells with larger plungers. To go into stretch in any further detail would be too complex to suit the purpose of this presentation.

It is well to call attention to the fact that all of the fluid weights given are based on lifting fresh water which weighs 8.325 pounds per gallon.

Oil of 10 Gravity = 8.32 pounds per gallon
Oil of 20 Gravity = 7.772 pounds per gallon
Oil of 30 Gravity = 7.286 pounds per gallon
Oil of 40 Gravity = 6.857 pounds per gallon
Oil of 50 Gravity = 6.476 pounds per gallon

Thus, if a well is lifting 40 gravity oil with no water present, then the fluid weight would be lightened in the same ratio as 6.857 is to 8.325, or a modification of 82 percent. The total fluid weight would be only 82 percent of that calculated originally, based on the weight per foot table for various sizes of pump plunger diameters. This modification should only be used when knowledge of reservoir conditions warrants it.

Since many fields have a water drive and since water flooding has become quite wide-spread, attention should be called to the fact that salt water is heavier than fresh water, and can actually weigh approximately 10 pounds per gallon as against the 8.325 pounds per gallon for fresh water. In this case, then the fluid weights should be increased in ratio in order to compensate for the heavier weight of salt water.

In the case of wells producing from solution-gas reservoirs, the gas coming out of solution will lighten the weight of the fluid column. Ordinarily, it might be reasonable to lighten the weight of the fluid column for applications to this type of well. This is not the case though, because most wells producing from solution-gas reservoirs pump awhile and then flow off due to the gas break-out. This condition makes it impossible to accurately counterbalance the well load. At times these wells will be overcounterbalanced and at other times they will be undercounterbalanced. This condition actually loads equipment in a manner not easily calculated. Therefore, there should be no modification due to solution-gas in the oil produced.

From an equipment standpoint, it is better if a back pressure valve is installed on the outlet of the tubing, so that sufficient pressure can be held on the tubing to prevent the well from agitating and flowing off. This equipment makes it possible to secure constant loading on the equipment, and proper counterbalancing can then be applied. This also often results in lower power costs on electric motors, as well as more production in some cases.

A proper application of pump and rods will result in the best possible application of unit pumper and engine.

To illustrate the fact and expand the scope of this inquiry to a more complete coverage of production equipment a second article will be presented. Next month simple basic calculations on the unit pumper and prime movers will be considered.

(To Be Continued)

TABLE 2

Strokes per Min. (SPM)	LENGTH OF POLISHED ROD STROKE IN INCHES (S)																		
	24	30	34	37½	44	54	64	74	84 7′	108 9′	120 10′	144 12′	168 14′	192 16′	216 18′	240 20′	300 25′	360 30′	420 35′
2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	.101	1.02	1.02	1.02
3	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.02	1.03	1.03	1.04	1.05	1.05
4	1.00	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.07	1.08	1.10
5	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.06	1.07	1.08	1.08	1.11	1.13	1.15
6	1.01	1.02	1.02	1.02	1.02	1.03	1.03	1.04	1.04	1.06	1.06	1.07	1.09	1.10	1.11	1.12	1.15	1.18	1.21
8	1.02	1.03	1.03	1.03	1.04	1.05	1.06	1.07	1.08	1.10	1.11	1.13	1.15	1.17	1.20	1.22	1.27	1.33	1.38
10	1.03	1.04	1.05	1.05	1.06	1.08	1.09	1.10	1.12	1.15	1.17	1.20	1.24	1.27	1.31	1.34	1.43	1.51	1.60
12	1.05	1.06	1.07	1.08	1.09	1.11	1.13	1.15	1.17	1.22	1.24	1.29	1.32	1.39	1.44	1.49	1.61	1.74	1.86
14	1.07	1.08	1.10	1.10	1.12	1.15	1.18	1.21	1.23	1.30	1.33	1.40	1.47	1.53	1.60	1.67	1.83	....	....
16	1.09	1.11	1.12	1.14	1.16	1.20	1.23	1.27	1.30	1.39	1.44	1.52	1.61	1.70	1.78	1.87	....	....	....
18	1.11	1.14	1.16	1.17	1.20	1.25	1.29	1.34	1.39	1.50	1.65	1.66	1.77	1.88	1.99	....	....	....	....
20	1.14	1.17	1.19	1.21	1.25	1.31	1.36	1.42	1.48	1.61	1.68	1.82	1.95	....	....	....	....	....	....
22	1.16	1.21	1.23	1.26	1.30	1.37	1.44	1.51	1.58	1.74	1.82	1.99	....	....	....	....	....	....	....
24	1.20	1.24	1.28	1.31	1.36	1.44	1.52	1.60	1.69	1.88	1.98	....	....	....	....	....	....	....	....
26	1.23	1.29	1.33	1.36	1.42	1.52	1.61	1.71	1.80	....	....	....	....	....	....	....	....	....	....
28	1.27	1.33	1.38	1.42	1.49	1.60	1.71	1.82	1.93	....	....	....	....	....	....	....	....	....	....
30	1.31	1.38	1.43	1.48	1.56	1.69	1.82	1.94	....	....	....	....	....	....	....	....	....	....	....
32	1.35	1.44	1.49	1.54	1.64	1.78	1.93	....	....	....	....	....	....	....	....	....	....	....	....

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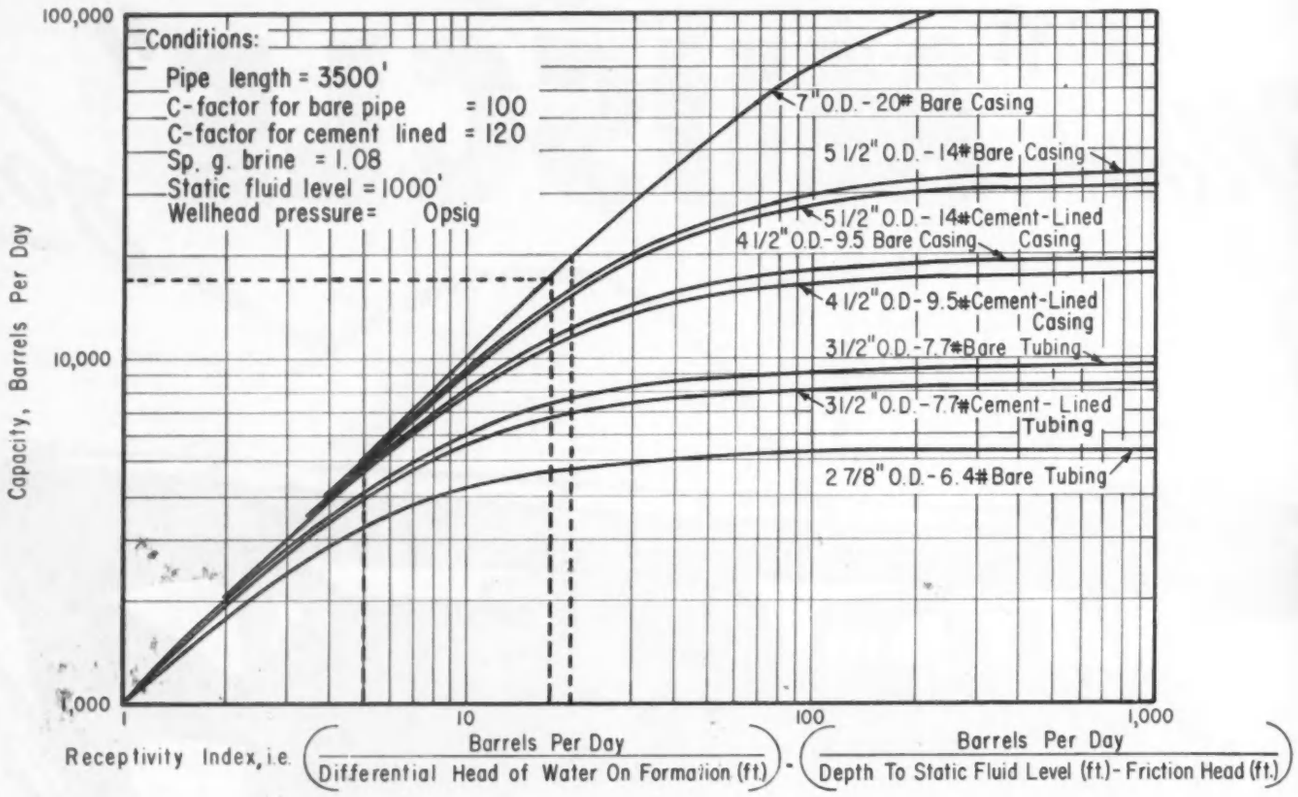

Conditions:
Pipe length = 3500'
C-factor for bare pipe = 100
C-factor for cement lined = 120
Sp. g. brine = 1.08
Static fluid level = 1000'
Wellhead pressure = 0psig
7" O.D. - 20# Bare Casing
5 1/2" O.D. - 14# Bare Casing
5 1/2" O.D. - 14# Cement-Lined Casing
4 1/2" O.D - 9.5 Bare Casing
4 1/2" O.D - 9.5# Cement-Lined Casing
3 1/2" O.D. - 7.7# Bare Tubing
3 1/2" O.D. - 7.7# Cement-Lined Tubing
2 7/8" O.D. - 6.4# Bare Tubing
Capacity, Barrels Per Day
100,000
10,000
1,000
1
10
100
1,000
Receptivity Index, i.e. (Barrels Per Day / Differential Head of Water On Formation (ft.)) - (Barrels Per Day / Depth To Static Fluid Level (ft.) - Friction Head (ft.))

FIGURE 1—Charts, similar to this, can be made easily to help you estimate your disposal well capacities through various sizes of pipe.

Effect of Tubing Size on Disposal Well May Be More Than You Think

For the non-technical man—an easily-used chart for determining the capacity of disposal wells with various-sized tubing (applicable to Trapp Field of Kansas, and similar conditions).

For the technical man—the how and why of constructing tubing-capacity charts for any well and conditions.

By F. M. CARROLL and G. H. CALHOUN
Shell Oil Company

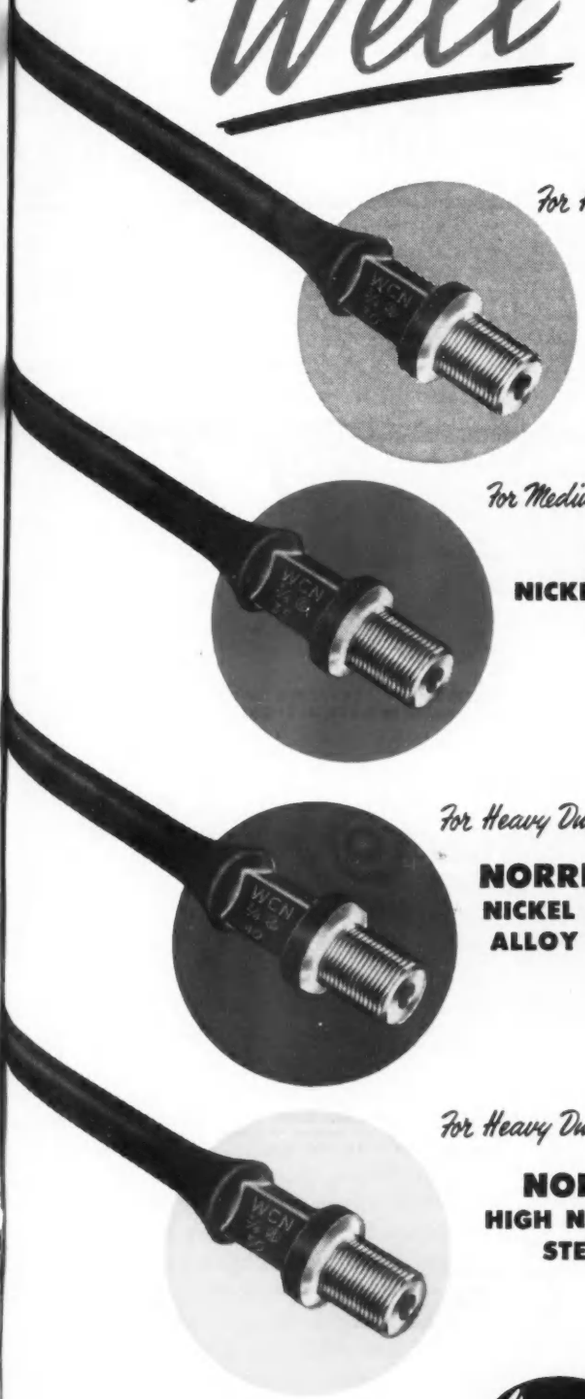
WHAT SIZE TUBING should be run in that new disposal well? Will changing to a larger tubing size in that old well pay out?

The operator and engineer are frequently faced with these questions. They, of course, have at hand one of the many head-loss tables that have been published. These are based on sound data, and are most valuable for solving problems relating to surface lines where only two variables must be considered simultaneously. (For example, pipe size vs. head loss, flow rate vs. head loss, etc.) However, these tables or curves can be highly deceptive if an attempt is made to employ them in estimating the effect of three simultaneous variables, such as pipe size, head loss, and flow rate.

This is precisely the situation encountered in sizing disposal-well tubing. If the size is enlarged, or if a smoother pipe is used, the head loss in the pipe of course diminishes, and a larger volume can be handled at the available head. If the downstream head (i.e., the back-pressure at the bottom of the well) remained constant, there would be no problem.

Well Developed...

SUCKER RODS



For Heavy Duty - Light Corrosion

NORRIS TYPE 30
CARBON MANGANESE
SUCKER ROD

For Medium Heavy Pumping - Med. Corrosion

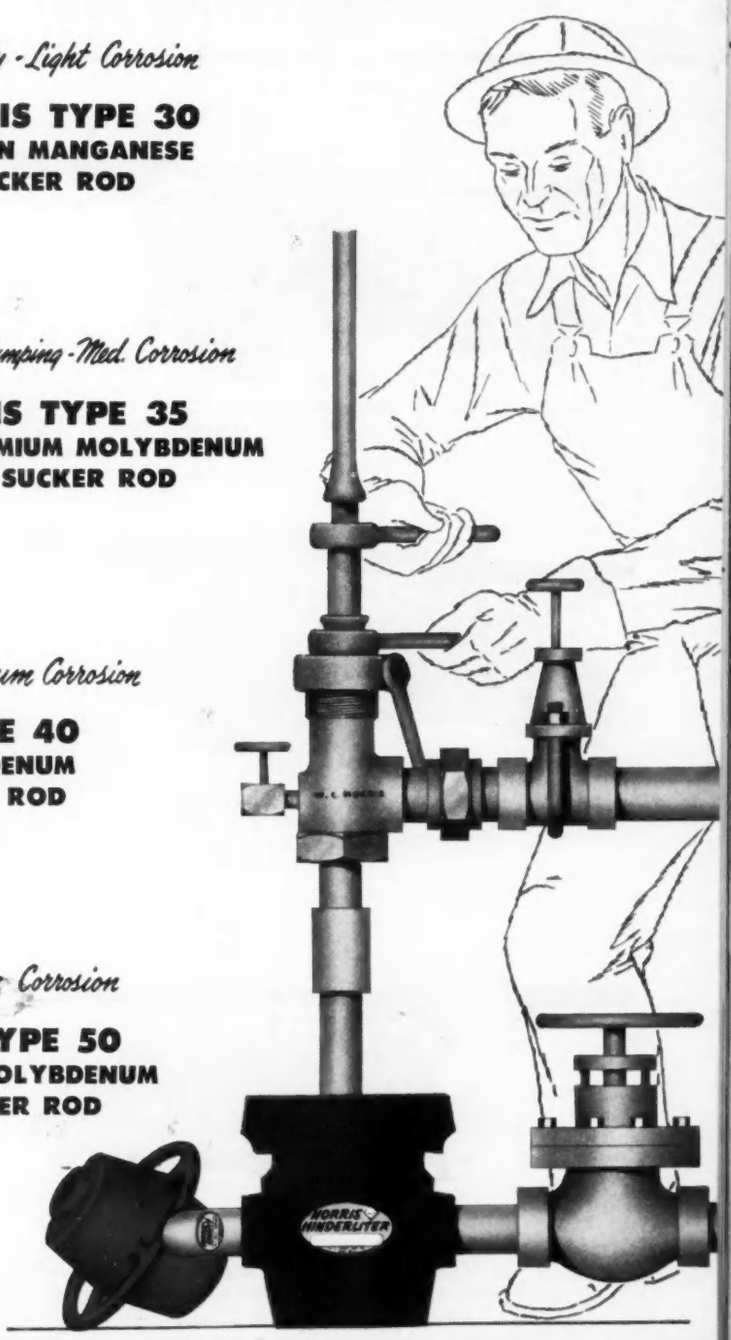
NORRIS TYPE 35
NICKEL CHROMIUM MOLYBDENUM
ALLOY SUCKER ROD

For Heavy Duty - Medium Corrosion

NORRIS TYPE 40
NICKEL MOLYBDENUM
ALLOY SUCKER ROD

For Heavy Duty - Severe Corrosion

NORRIS TYPE 50
HIGH NICKEL MOLYBDENUM
STEEL SUCKER ROD



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with positive clutches. Three sizes with proper brake capacity and power for servicing from 3,500 ft. to 8,000 ft.

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However, the capacity increase that larger tubing tends to bring about is immediately offset, to a degree, by the resistance of the formation to the larger input. This puts the problem outside the realm of any of the reference material or normal calculation methods of which the authors have knowledge. To remedy this deficiency, the curve sheet shown as Figure 1 was constructed. It is necessary to construct these charts for specific conditions; the one printed is applicable to Arbuckle limestone wells in western Kansas. Construction of the charts for any prevailing set of conditions is not difficult, and is described later herein.

On the chart shown (Figure 1), it will be noted that capacity is plotted against a "receptivity index," which term is defined on the chart. In the ordinary employment of the chart, no direct use is made of this term. However, it is the only usable abscissa for the curves, because only the receptive characteristics of the formation itself remain constant as other conditions are varied.

The use of Figure 1 is simple. A hypothetical case has been illustrated on the chart. Let it be assumed that a newly-completed disposal well has tested 17,000 bpd maximum capacity by gravity through 7-inch OD 20-pound casing. (The test of course must be realistic, with sufficient time allowed for the well to reach equilibrium conditions at the test rate.)

At the 17,000 bpd point on the ordinate, a horizontal line is projected until it intersects the curve for 7-inch casing. From this intersection, a line is projected downward. (It will be observed, in passing, that this vertical line indicates a receptivity index of 17.5, but as previously stated, it is unnecessary to make use of this figure, unless it be merely as a convenient short-hand description of the formation's receptive ability.)

To arrive at the well capacities with 3½-inch OD, 4½-inch OD, and 5½-inch OD cement-lined tubing, it is necessary only to observe the intersection of the vertical line with each of these tubing curves. They are, respectively, about 6600, 10,700 and 14,000 bpd.

Tubing Size vs. Receptivity. In some situations, the capacity of the newly-drilled or newly-restored well is the governing consideration, and other factors may be of only secondary importance. These are distress cases,

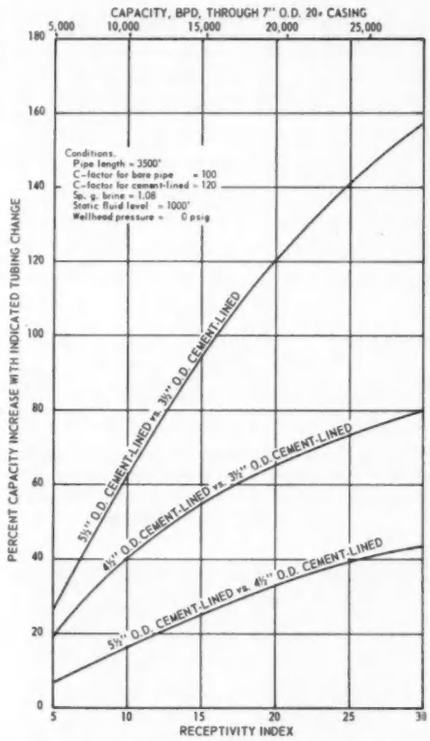
CAPACITY, BPD, THROUGH 7" O.D. 20# CASING
5,000
10,000
15,000
20,000
25,000
PERCENT CAPACITY INCREASE WITH INDICATED TUBING CHANGE
RECEPTIVITY INDEX
Conditions:
Pipe length = 3500'
C-factor for bare pipe = 100
C-factor for cement-lined = 120
Sp. g. brine = 1.08
Static fluid level = 1000'
Wellhead pressure = 0 psig
5½" O.D. CEMENT-LINED vs. 3½" O.D. CEMENT-LINED
4½" O.D. CEMENT-LINED vs. 3½" O.D. CEMENT-LINED
5½" O.D. CEMENT-LINED vs. 4½" O.D. CEMENT-LINED

FIGURE 2—Increased tubing size will not make a good well out of a poor one. For a given receptivity index, however, tubing size makes a considerable difference.

where the volume of water to be disposed is relatively close to the best capacity obtainable. Where these conditions prevail, and larger initial capacity is thus the justification for larger tubing, the payout is much better on wells with a good receptivity index. For example, increasing tubing size from 3½-inch OD to 4½-inch OD, both cement-lined, will give only a 19 percent increase in initial capacity in a well with an index of 5. If the index were 20, the same change would give an increase of 65 percent. In short, large tubing will enable a good well to realize a larger amount of its potentiality, but it cannot make a poor well into a good one. Figure 2 is a graphical presentation of these relationships for the range of receptivity indices commonly encountered.

Tubing Size vs. Cleanout Frequency. In average operations, however, the principal profitability of larger tubing is likely to lie in a different direction, that of reduced cleanout frequency. Referring again to Figure 1 and to the 17.5-receptivity-index example used to illustrate it, let it be assumed that the well was required to accept only 6000 bpd, and that the operator, in an excessively economical mood, equipped it with 3½-inch OD cement-lined tubing, giving an initial capacity of 6600 bpd, as previously noted. By following back along the curve on Figure 1 for this size tubing, it is seen that the curve intersects the 6000 bpd ordinate at a receptivity index of 12.3, indicating that the well cannot handle the required volume when plugging has diminished the index below this value.

Figure 3 illustrates the general shape of this decline. Observations of the permeability of cores in flood-pot apparatus, as well as field data on disposal-well performance, show that

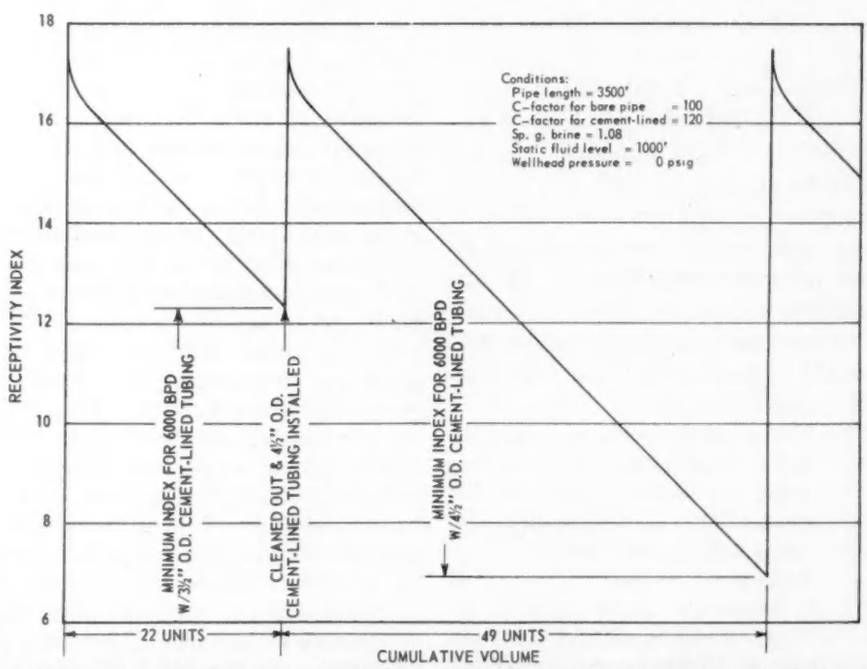
RECEPTIVITY INDEX
Conditions:
Pipe length = 3500'
C-factor for bare pipe = 100
C-factor for cement-lined = 120
Sp. g. brine = 1.08
Static fluid level = 1000'
Wellhead pressure = 0 psig
MINIMUM INDEX FOR 6000 BPD W/3½" O.D. CEMENT-LINED TUBING
CLEANED OUT & 4½" O.D. CEMENT-LINED TUBING INSTALLED
MINIMUM INDEX FOR 6000 BPD W/4½" O.D. CEMENT-LINED TUBING
22 UNITS
49 UNITS
CUMULATIVE VOLUME

FIGURE 3—Enlarged tubing size reduces the frequency of cleanout. Here is a typical calculated effect on the length-of-run as a result of increased tubing size.

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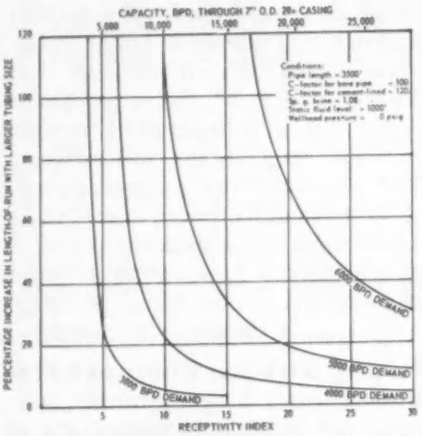
CAPACITY, BPD, THROUGH 7" O.D. 20# CASING
PERCENTAGE INCREASE IN LENGTH-OF-RUN WITH LARGER TUBING SIZE
RECEPTIVITY INDEX
6000 BPD DEMAND
5000 BPD DEMAND
4000 BPD DEMAND
3000 BPD DEMAND

FIGURE 4—A percentage increase in length-of-run with larger tubing size comparing 4½ inch O.D. cement lined tubing and 3½ inch O.D. cement lined tubing.

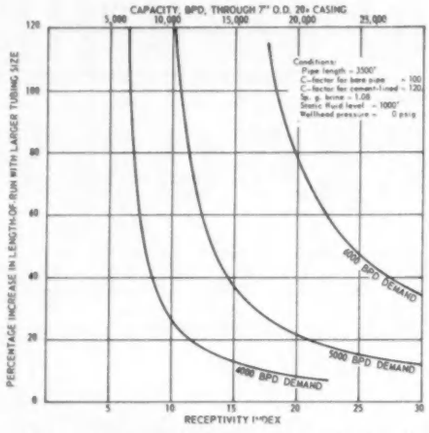
CAPACITY, BPD, THROUGH 7" O.D. 20# CASING
PERCENTAGE INCREASE IN LENGTH-OF-RUN WITH LARGER TUBING SIZE
RECEPTIVITY INDEX
6000 BPD DEMAND
5000 BPD DEMAND
4000 BPD DEMAND

FIGURE 5—A percentage increase in length-of-run with larger tubing size comparing 5½ inch O.D. cement lined tubing and 3½ inch O.D. cement lined tubing.

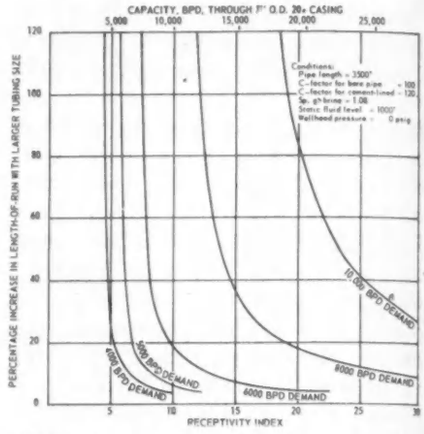
CAPACITY, BPD, THROUGH 7" O.D. 20# CASING
PERCENTAGE INCREASE IN LENGTH-OF-RUN WITH LARGER TUBING SIZE
RECEPTIVITY INDEX
10,000 BPD DEMAND
8000 BPD DEMAND
6000 BPD DEMAND
5000 BPD DEMAND
4000 BPD DEMAND

FIGURE 6—A percentage increase in length-of-run with larger tubing size comparing 5½ inch O.D. cement lined tubing and 4½ inch O.D. cement lined tubing.

there is generally a steep initial decline of brief duration, followed by a flatter decline-volume relationship that approximates a straight line.

Referring again to Figure 3, assume that the operator is dissatisfied when he is forced to recondition after a run down only to an index of 12.3, and retubes his well with 4½-inch OD cement-lined tubing. Figure 1 shows that this will permit an index decline to 6.9 before the 6000 bpd capacity is reached. Figure 3 demonstrates graphically the increased volume disposed between reconditioning operations. On the scale used, the volume is raised from 22 units to 49 units, an increase of 123 percent. This is substantially the same as the percentage increase in index decline; the old decline was 17.5 — 12.3, or 5.2, and the new decline is 17.5 — 6.9, or 10.6, giving a percentage increase of about 104 percent in index decline. Whether or not the reduction in cleanout expense would show a profit on the increased tubing investment in this hypothetical well is of course dependent upon the frequency and cost of the reconditioning operations for the individual case.

There are three generalizations that should be made concerning this phase of the subject:

(1) If the decline-volume curve is convex downward, the actual increase in length-of-run will be greater than the theoretical increase calculated from the ratio of the index declines (as in Figure 3, where the actual increase in length-of-run would be 123 percent as against a theoretical increase of 104 percent).

(2) If the curve should be convex upward, the actual increase will be less than the calculated. However, this does not occur in any circumstances regarded as normal, and it is therefore conservative to predict the increased run on the basis of a straight-line relationship.

(3) The slope of the decline curve is immaterial to the prediction of percentage improvement. Whether the slope be steep or flat, the ratio of increase will be the same. An unusually flat decline, however, indicates a low annual reconditioning expense, and the annual saving in dollars will therefore be small, though the percentage saving is unchanged.

As previously stated, the better improvements in initial capacity are possible in the wells with the better receptivity indices. The reverse condition prevails in the case of improvements in length-of-run. Here, the better results are to be had in low-index wells. In the example illustrated by Figure 3, it is obvious that the additional index decline made possible by the tubing-size increase can be only 5.4 index units, regardless of what the initial index might have been. Had the initial index been 20, the permissible decline with the smaller tubing would have been 7.7, and the addition of 5.4 units would have amounted to an improvement of only 70 percent, as contrasted with the previously-calculated 104 percent.

This particular situation, plus all others within the range of customary operations, are detailed in Figures 4, 5, and 6. Among the observations that can be made from these curves are the following:

- If the capacity demand on a well is within the range for which 3½-inch tubing can practically be considered, a change to 4½-inch tubing is ordinarily all that can be justified by extension of length-of-run. Note that for demands of 4000, 5000, and 6000 bpd, Figure 5 shows virtually no improvement over Figure 4 for reasonable receptivity indices. At the 17.5 index used for the example in Figure 3, a further increase in tubing size to 5½-inches would have lengthened the run only about 6 percent, as shown by Figure 6. However, with a demand of 6000 bpd, the improvement by running 5½-inch tubing becomes consequential for indices below 10.
- The ranges of receptivity indices which are favorable to an increase in tubing size will differ widely, depending upon whether the immediate need is for longer runs between cleanouts, or for greater maximum capacity. Note on Figure 6 that in most cases an enlargement from 4½-inch to 5½-inch tubing gives significantly longer runs only where the index is below 10, whereas Figure 2 showed that the same change produces good capacity increases only where the index is above 10. This points up the essentiality of correctly appraising the type of disposal problem at hand; its importance cannot be over-emphasized.
- At higher demands, such as 10,000 bpd (see Figure 6), even wells with excellent indices can show a good payout on 5½-inch cement-lined casing used as tubing. However, the

previously-stated rule still applies—the lower the index, the greater the potential profit from run extension.

Input Through Casing for Special Circumstances. The curve for 7-inch OD casing was included on Figure 1 for two reasons. First, it permits correlation of tests on newly-drilled, untubed wells, and foretells the results that may be expected during routine use. Secondly, it provides data for the solution of a problem that is somewhat likely to arise in the marginal period of a field—the loss of a disposal well at a time when the oil reserves are too low to justify a replacement well.

The following example will show how a dilemma of this nature might be escaped. Let it be assumed that a nearly-depleted field is served by two disposal wells, each taking 9000 bpd. The total remaining water is estimated to be 8 million barrels. The wells are good; they will operate for a reasonable length of time before the index declines to 20. This indicates a firm capacity of about 11,500 bpd per well through 4½-inch cement-lined tubing. Through a mishap, one disposal well is irretrievably lost. By changing to 5½-inch tubing, the firm capacity of the remaining well would be increased to 15,000 bpd. However, this would necessitate premature abandonment of sufficient production to reduce the water by 3000 bpd, and this is of course undesirable. A new well might be drilled and equipped for $45,000, but the future water production from the wells threatened with abandonment is only 3 million barrels. Thus the mere investment amortization would amount to 15 mills per barrel on the extra 3000 bpd of water that necessitated the investment.

When operating expenses are added to this, the cost is too high. However, it might be found that an inhibitor dosage costing two mills per barrel would enable the bare casing to last the life of the field. By disposing through the casing, a reliable capacity of 19,500 bpd, adequate for all production, could be had. The inhibitor cost would be $16,000, a saving of $29,000 over the alternate course of replacing the well. The same expedient, on a smaller scale, might be used in wells with 5½-inch or 4½-inch OD casing.

Method of Constructing Charts for Other Conditions. Unfortunately, a chart such as Figure 1 is applicable to only a single set of conditions. This particular one is for typical wells in the Trapp field of Kansas. However, it is not difficult to prepare such a chart for any field in which an operator may be sufficiently active to justify the expenditure of a reasonable amount of engineer-time.

Head-loss figures for each size of tubing to be considered are first calculated by a slightly-modified Hazen-Williams formula, using C-factors regarded as appropriate. The modification consists of introducing below the line the specific gravity of the water; the basic formula is for fresh water with a gravity of unity. Two widely-separated values, such as 1000 and 100,000 bpd, are calculated for each size. The head-loss values thus obtained are plotted against flow-rate on log-log paper, and a straight line is drawn through each pair of points. As a check against error, it is well to calculate the head-loss at a third and intermediate rate; if this point does not fall on the straight line, a computation error exists.

Using data from this curve sheet, head losses at various flow rates for the desired length of tubing string are then calculated. The total head-loss for the string is then subtracted from the static fluid level. The remainder is the head available for overcoming formation resistance, and therefore, if the well is at capacity for a particular flow rate, the receptivity index is the flow rate divided by the aforesaid remainder head corresponding with that flow rate. For well-head pressures above atmospheric, it is necessary only to express that pressure in feet-of-head of water of the gravity being handled, and use the sum of that head and the static fluid level as the base from which to subtract the pipe-friction loss. Plotting the results of these computations gives the equivalent of Figure 1. Any type of coordinate paper may be used for this, but log-log paper is probably best adapted because of its wide range. On the other hand, if straight coordinate paper is used for Figure 1, an undistorted picture of length-of-run possibilities is obtained. This would permit a graphical evaluation of such potentialities directly from Figure 1. Various factors, such as the range to be spanned, will determine the choice of papers for individual cases. (Note that this applies only to the capacity vs. receptivity index sheet; only log-log paper is satisfactory for the flow-rate vs. head-loss plotting.)

To some, the computations described above may seem unduly burdensome. However, the operator who has at his command such a set of data may ultimately find in it the means to make three disposal wells do the work of four, or to reduce his reconditioning frequency and annual cost by 20 percent or more. At this time, he will be repaid many-fold for his preliminary engineering expense. —**The End**

About the Authors

Carroll

Calhoun

FREDERICK M. CARROLL was graduated from Purdue University with a degree in mechanical engineering. After working for The Ohio Oil Company in Robinson, Ill., he joined Shell Oil Company in 1936 and spent six years in various positions in the Illinois and Kansas fields. In 1940 he was named to the mechanical engineering staff of the Area Exploration and Production office in Tulsa. He is a past president of the Engineers Club of Tulsa and has served as vice chairman and chairman of the API Mid-Continent district Subcommittee on Production Practices.

G. H. CALHOUN was graduated from the University of Delaware in 1931, with a B.S. degree in civil engineering. After working on a dam construction job in the Canal Zone and two years with the U. S. Coast and Geodetic Survey, he joined Shell Oil Company in 1936 as a junior mechanical engineer. He is now the division mechanical engineer in Shell's Wichita, Kansas, office.

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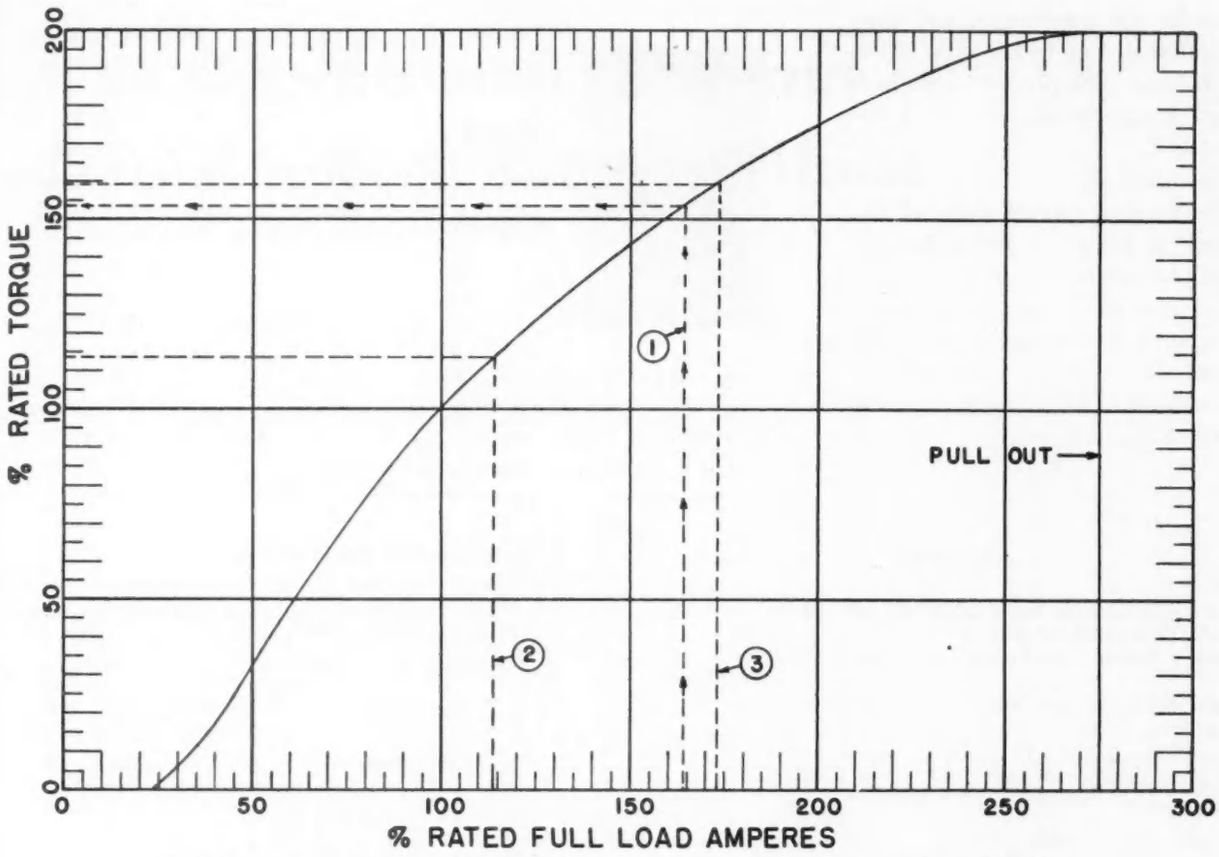


FIGURE 1—Amp-torque curve applying to high starting torque and low starting current electric motors.

Simplify Your Calculations

A simplified method of calculating torque load on the gear teeth of electrically pumped wells has been developed using a peak ammeter approach . . . and it's accurate.

By JOHN C. SLONNEGER
Continental Supply Company
Dallas

PRODUCERS WHO are pumping their wells electrically will find this new approach to computing the peak torque on gears a real help. This method gives results which are in very close agreement with dynamometer analysis. It already has been approved for use by some of the major operators in the industry for their production activity.

Only four items of data and the illustrated curve are required with this procedure.

• **First,** secure the peak ampere demand being required by the motor. This can be done in several ways—by accurately reading the needle of a clip-on hand ammeter, or by reading the chart taken by a recording ammeter. In any case, accuracy of reading will give the proper results desired.

• **Second,** secure from the nameplate of the motor, the following—

1. Full load ampere rating.
2. Full load revolutions per minute.
3. Nominal horsepower.

• **Third,** measure the size of sheaves and figure the drive ratio of the V-belt drive.

• **Fourth,** find the ratio of the gear reducer from its nameplate.

Note—the third and fourth steps can be combined by dividing the *actual* rpm of the motor by the strokes per minute on the well. This gives the over-all ratio.

With the above data in hand, proceed as follows—

1. Solve the following formula to find the *Rated* Torque of the motor—

$$\text{Rated Torque} = \frac{\text{Nominal HP} \times 63{,}000}{\text{Full Load RPM}} = \text{Inch Pounds Torque}$$

2. Solve for percent of full load ampere rating that motor is actually drawing—

$$\%\ \text{Full Load Ampere Rating} = \frac{\text{Peak Amp Reading}}{\text{Full Load Amperes}}$$

3. Now, refer to the curve. Start at percent full load ampere axis at the percent figured in No. 2—go up until the curve is reached, and from that point proceed horizontally to the percent rated torque axis and read the percent of rated torque that the motor is putting out at the percent of full load amps it is drawing.

4. Now multiply the rated torque from No. 1 by the percent of rated torque from No. 3—this gives the actual torque output of the motor at the ampere reading taken.

5. Now—multiply this actual motor

torque by the drive ratio, and then multiply that sum, by the ratio of the gear reducer. This product is the inch pounds torque being carried by the gear teeth.

Or—multiply the actual motor torque by the over-all ratio of the pumper, to secure the torque loading of the gear teeth.

This procedure, and the attached curve, apply to the type of motors in general use in the oil fields. Special type of motors will require different ampere-torque curves.

About the Author

J. C. SLONNEGER has been with the Continental Supply Company of Dallas since 1937 and is the author of many technical and engineering papers. He has been active in petroleum engineering, particularly in the sucker rod vibration field. He became associated with Caterpillar Tractor Company and International Harvester Company after leaving the University of Illinois 43 years ago. In 1931 he joined the Falk Corporation as supervisor of research engineering. He has served on various committees of API and has been a member of The Society of Automotive Engineers for 39 years.

EXAMPLE

Data:

11-DE57-F with 10 Hp, 1200 RPM, 220-440 V
Oil Field Pumping Motor
Ampere Rating (Full Load) from Name Plate = 15 @ 440
30 @ 220

Full Load RPM from Name Plate = 1155.
Gear Ratio = 30.1 to 1.
Unit Sheave = 16″ P.D.
Motor Sheave = 7.5″ P.D.
S.P.M. = 18.

Ampere Peak Reading
(Taken on Leads while Unit in operation) = 17.

Solution:

#II on Curve

1. **Solve** for Rated Torque on Motor—

$$\text{Rated Torque} = \frac{\text{HP} \times 63{,}000}{\text{Full Load RPM}}$$

$$= \frac{10 \times 63{,}000}{1155} = 545 \text{ In. Lbs.}$$

∴ 545 "# is Rated Torque at Full Load.

2. **Solve** for % of Full Load Ampere Rating that Motor is drawing.

$\frac{17}{15} = 113\%$ of Full Load Ampere Rating that Motor is drawing.

3. **From Curve**—read up from % Full Load Ampere axis to curve, then across to % Rated Torque Axis, and find that Motor is putting out 112% of Rated Torque, or
(1.12) (545) = 610"#.

4. **Multiply** the Torque being put out by the Motor by the Drive Ratio, and this product is multiplied by the Gear Ratio—to find the Torque Loading on the Gear Teeth—

$$(610)\left(\frac{16}{7.5}\right)(30.1) = 39{,}200\text{"\#} = \textbf{Load on Gear Teeth.}$$

#III on Curve

Now—if the Peak Ampere Reading had been 25, instead of 17, then—

$\frac{25}{15} = 1.675 = 167.5\% =$ Peak Amps Above Full Load Amps.

then, from curve, we find that at 167.5% of Full Load Amps we have 158% of Rated Torque, or

(1.58) (545) = 862"#

then—

$$(862)\left(\frac{16}{7.5}\right)(30.1) = 55{,}200\text{"\#}$$ **Peak Torque on Gears**

DATA SHEET FOR PEAK AMPERE TORQUE CALCULATIONS

1. **Peak Ampere Demand** = _____ Amps.
Taken by Ammeter while Pumper is operating.

2. **Name-plate Data** (from Installed Motor).
a. Full Load Ampere Rating = _____ Amps.
b. Full Load RPM = _____ RPM.
c. Nominal Horsepower = _____ Hp.
Note: Full Load Peak Ampere Rating must correspond to the connected voltage—thus if nameplate says 15 Amps @ 440V, 30 Amps @ 220V, and 440V is connected, then use 15 Amps in data.

3. **V-Belt Drive Ratio** = _____ To 1.
a. P.D. of Unit Sheave = _____".
b. P.D. of Motor Sheave = _____".

$$\text{c. Ratio} = \frac{\text{P.D. of Unit Sheave}}{\text{P.D. of Motor Sheave}} = \left(\frac{\quad}{\quad}\right) = \_\_\_\_$$

4. **Gear Reducer Ratio** = _____ To 1.
From Nameplate on Reducer, or from correct records or bulletins.
Note: Steps No. 3 and No. 4 can be combined, to secure over-all ratio, as follows—

$$\text{Over-all Ratio} = \frac{\text{Full Load RPM (from No. 2)}}{\text{SPM of Well}} =$$

$$\left(\frac{\quad}{\quad}\right) = \_\_\_\_ \text{ To 1.}$$

5. **Rated Torque of Motor** = _____"#/RPM. from—

$$\text{Rated Torque} = \frac{\text{Nominal Hp} \times 63{,}000}{\text{Full Load RPM}} =$$

$$\frac{(\quad) \times (63{,}000)}{(\quad)} = \_\_\_\_$$

6. **Percent of Full Load Ampere Rating** = _____% from—

$$\%\text{ Full Load Amp. Rating} = \frac{\text{Peak Ampere Demand (from No. 1)}}{\text{Full Load Ampere Rating (from 2)}} =$$

$$\left(\frac{\quad}{\quad}\right) = \_\_\_\_\_\%$$

7. From Curve, read from % Full Load Ampere Rating (as figured in No. 6) up to curve, then horizontally to % Rated Torque Axis, and find that the Motor was putting out _____% of its Rated Torque (as figured in No. 5).

8. **Actual Torque Output** = _____"#/RPM. from—
Torque Output = (% from No. 7) × (Rated Torque from No. 5) = ( ) × ( ) = _____"#/RPM.

9. **Peak Torque on Gear Teeth** = _____"# Torque from—
Peak Torque = (Actual Torque Output from No. 8) × (V-Belt Drive Ratio from No. 3) × (Ratio of Reducer from No. 4)
Or—
= (Actual Torque from No. 8) × (Over-all Ratio from Note)
= ( ) × ( ) × ( ) = _____.

How to Operate and Maintain Hydraulic Surface Pumping Units

Apply these principles to get . . .

- Improved equipment performance
- Extended service life
- Increased dependability
- Lower lifting costs

By F. C. CUMMINGS
Axelson Manufacturing Company, Tulsa

MAXIMUM EFFICIENCY from surface pumping units is attained only by an operator who is well versed in the operation and maintenance of this equipment. Knowledge of the operating factors of any piece of equipment naturally results in more efficient operation. Likewise, knowing how to maintain equipment saves time and downtime and is reflected in the profits.

These basic principles are particularly true in the operation of surface pumping units.

Hydraulic pumping units are classified as surface and subsurface, counterbalanced and non-counterbalanced. This article applies to the surface units which reciprocate a sucker rod string connected to a subsurface plunger pump, and to counterbalanced and non-counterbalanced units based on compressed gas.

OPERATION

A non-counterbalanced unit is a light-duty pumper. Consequently, it is able to perform its required work with a minimum number of operating parts. A comparison may be drawn between hydraulic and beam unit components as follows: A working piston and cylinder assembly replaces the horsehead, bridle carrier bar and walking beam; the reversing mechanism replaces the crank; the power pump replaces the gear reducer and the piping replaces the pitman.

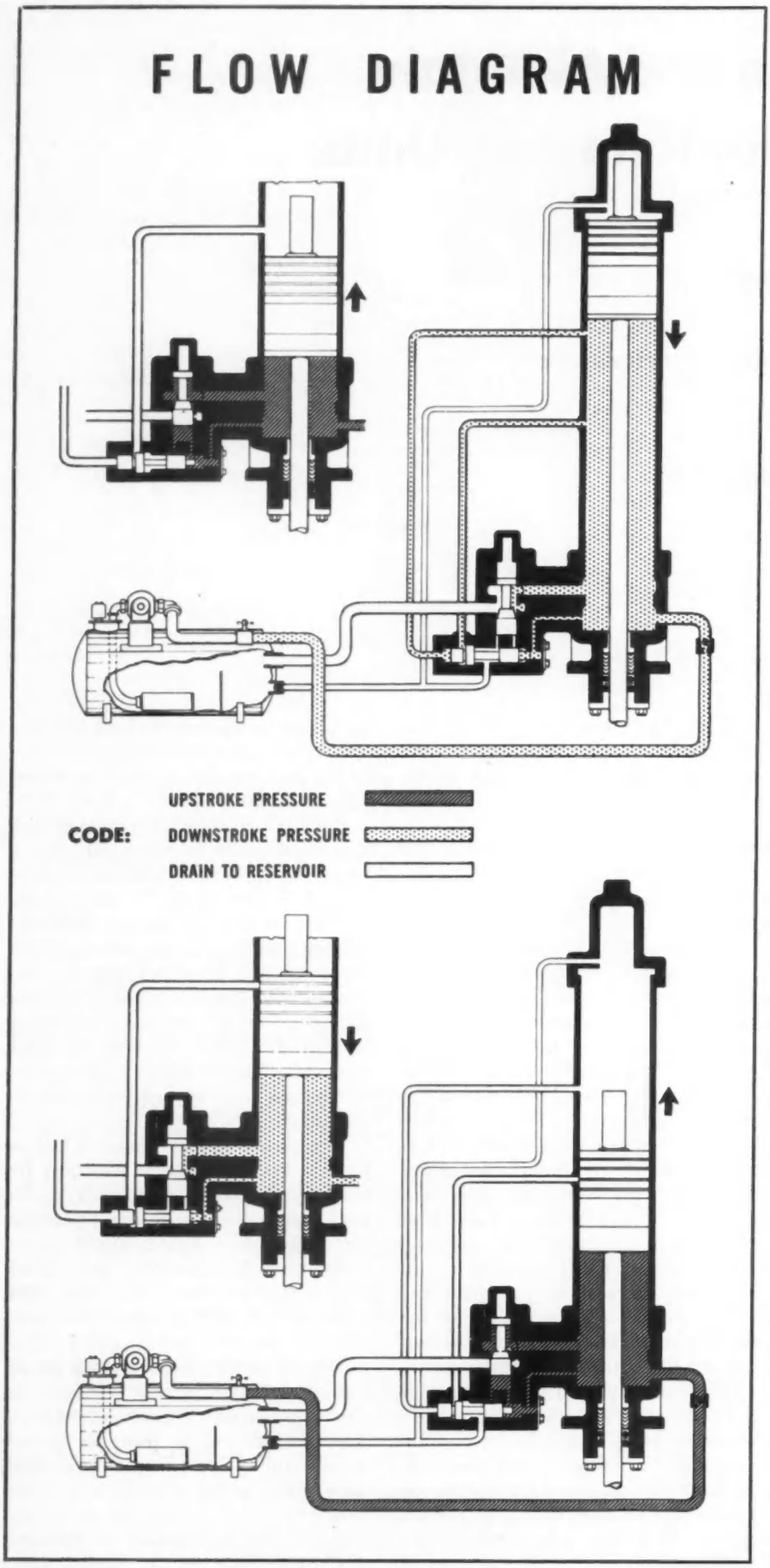
Each of these components and their relation to the unit must be understood for proper maintenance and trouble shooting. The functional flow diagrams show four positions of the working piston through the cycle, two for the upstroke and two for the downstroke. From the diagrams it is apparent that during the upstroke a closed circuit is maintained from the power pump to the lower side of the working piston. During the downstroke an open circuit exists; that is, power fluid enters the cylinder at one port and exits from another. This type of circuit indicates that speed of the complete cycle is controlled by two methods. First, changing the speed of the power pump, which either reduces or increases the upward piston velocity. Second, changing the downstroke speed by manipulation of the cylinder discharge valve.

Control of the discharge valve is the governing factor in successfully operating a hydraulic pumping unit. It must remain closed during the upstroke and be open during the downstroke. This has been accomplished by use of a spool type valve which when closed will seal the discharge port. Operating pressure on the underside of the spool during the upstroke prevents the spool from opening the discharge port.

Prior to the piston reaching the maximum point on the upstroke a control port on the cylinder is pressurized by the passage of the piston. Pressure in the line shifts a differential area pilot valve such that the source of pressure holding the discharge valve closed is blocked and the fluid previously pressurized is vented to a gravity drain, back to the fluid reservoir. The discharge valve then opens and an open-type circuit is created.

The piston will continue to fall as fluid leaves the cylinder and only by shifting the pilot valve back to its previous position will the hydraulic circuit be once again closed as required for the upstroke. Analysis of the diagrams show that the pilot valve will be shifted when the lower cylinder control line is vented.

Operation of the compressed gas or air counterbalanced unit is in general similar to a non-counterbalanced unit. The unit differs in that the power pump utilizes pressurized fluid and merely boosts this pressure to provide power to the working piston during the upstroke; and to take the cylinder discharge fluid, on the downstroke, and return it to the pressurized oil



LIGHT DUTY NON-COUNTERBALANCED UNIT

receiver. Both portions of the cycle have been diagramed. It is seen that the pilot valve merely ports pressurized fluid to an auxiliary piston which operates a rotary type reverse valve. The pilot valve operation is essentially the same as previously explained. Control ports located on the cylinder actuate it as required.

Two types of power pumps have been successfully used on units of this type, the positive and the variable displacement. The variable displacement or centrifugal pump requires the least amount of attention once it has been properly applied. After the proper pump speed has been determined the correct counterbalance setting may be made. This setting will provide identical times for the up and down portion of the cycle. If insufficient air counterbalance is used, the upstroke will be slower than the downstroke. Excessive pressure will unbalance the unit oppositely.

INSTALLATION

Alignment. Maintenance and unit downtime may be reduced considerably if proper steps are taken prior to the installation of a hydraulic unit. It is imperative that the unit be aligned properly in order to reduce stuffing box packing wear, polished rod wear and hydraulic oil leakage.

A cement mat of proper dimensions and level with respect to the surrounding terrain does not alone insure proper alignment of the unit. It is important to surface the mat so that it is perpendicular to the well bore. If this perpendicularity cannot be achieved with the mat it is then advisable to shim the unit until properly aligned.

An alignment problem recently occurred wherein no leakage resulted, but extreme polished rod friction resulted, represented by an appreciable increase of load range on the unit. Analysis indicated shimming to be necessary. Shims were placed at various points underneath the unit base until operating pressure readings showed the unit load to be compatible to fluid and rod weight only. A six-inch maximum differential height was measured at one point on the base as compared to the original mat.

Air Leakage. It is difficult to entirely eliminate air leakage. However, minimizing the leaks will reduce ex-

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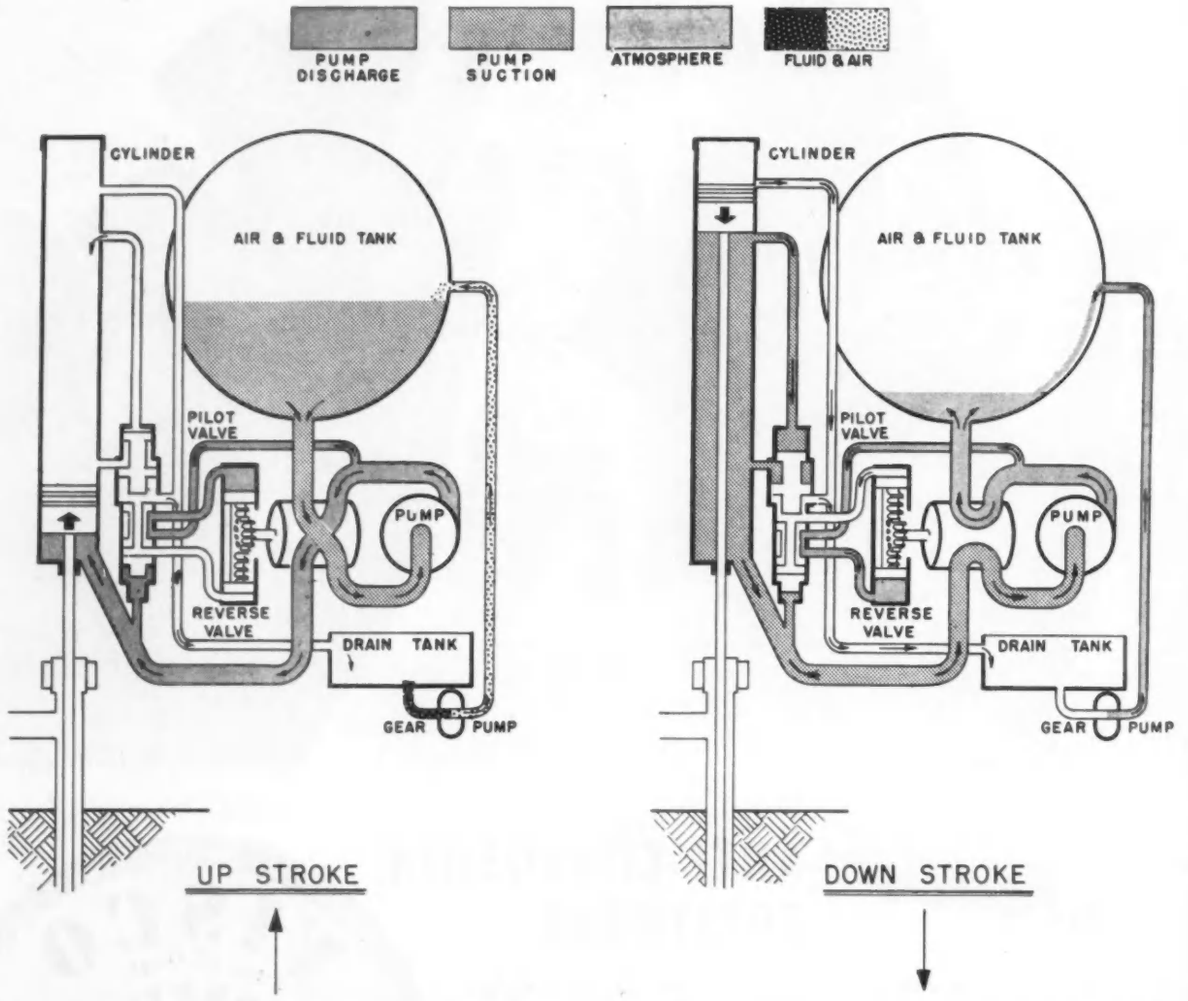

FLUID FROM THE DISCHARGE SIDE OF THE CENTRIFUGAL PUMP PASSES THROUGH THE PILOT VALVE AND IS DIRECTED TO THE RIGHT HAND SIDE OF THE OPERATING PISTON OF THE REVERSE VALVE, MOVING IT TO THE LEFT. THIS MOVEMENT ROTATES THE PLUG VALVE 90° THRU THE RACK AND PINION.

FLUID UNDER AIR PRESSURE IN THE FLUID TANK THEN PASSES THRU THE REVERSE VALVE AND CENTRIFUGAL PUMP WHERE ITS PRESSURE IS BOOSTED AND THEN TO THE HYDRAULIC CYLINDER, LIFTING THE PISTON WITH ITS LOAD OF RODS AND OIL.

NEAR THE TOP OF ITS STROKE, THE PISTON PASSES A PORT DIRECTING PRESSURE FLUID TO THE PILOT VALVE, FORCING IT DOWN. FLUID FROM THE DISCHARGE SIDE OF THE PUMP PASSES THRU THE PILOT VALVE TO THE LEFT HAND SIDE OF THE OPERATING CYLINDER OF THE REVERSE VALVE, REVERSING THE FLOW THRU THAT VALVE. FLUID IS REMOVED FROM UNDER THE PISTON OF THE HYDRAULIC CYLINDER BY THE CENTRIFUGAL PUMP AND RETURNED TO THE FLUID TANK AGAINST THE TANK PRESSURE.

NEAR THE BOTTOM OF ITS DOWN STROKE THE PISTON RETURNS THE PILOT VALVE TO ITS FIRST POSITION AND THE OPERATING CYCLE IS REPEATED.

LEAKAGE RETURN

EXHAUST FLUID FROM THE VALVES AND LEAKAGE PAST THE PISTON IS COLLECTED IN THE DRAIN TANK AND RETURNED TO THE FLUID TANK BY THE GEAR PUMP. THIS PUMP HAS AN EXCESS CAPACITY SO THAT ON A PORTION OF THE CYCLE IT PUMPS AIR AS WELL AS FLUID INTO THE FLUID TANK, MAINTAINING THE AIR PRESSURE IN THE TANK.

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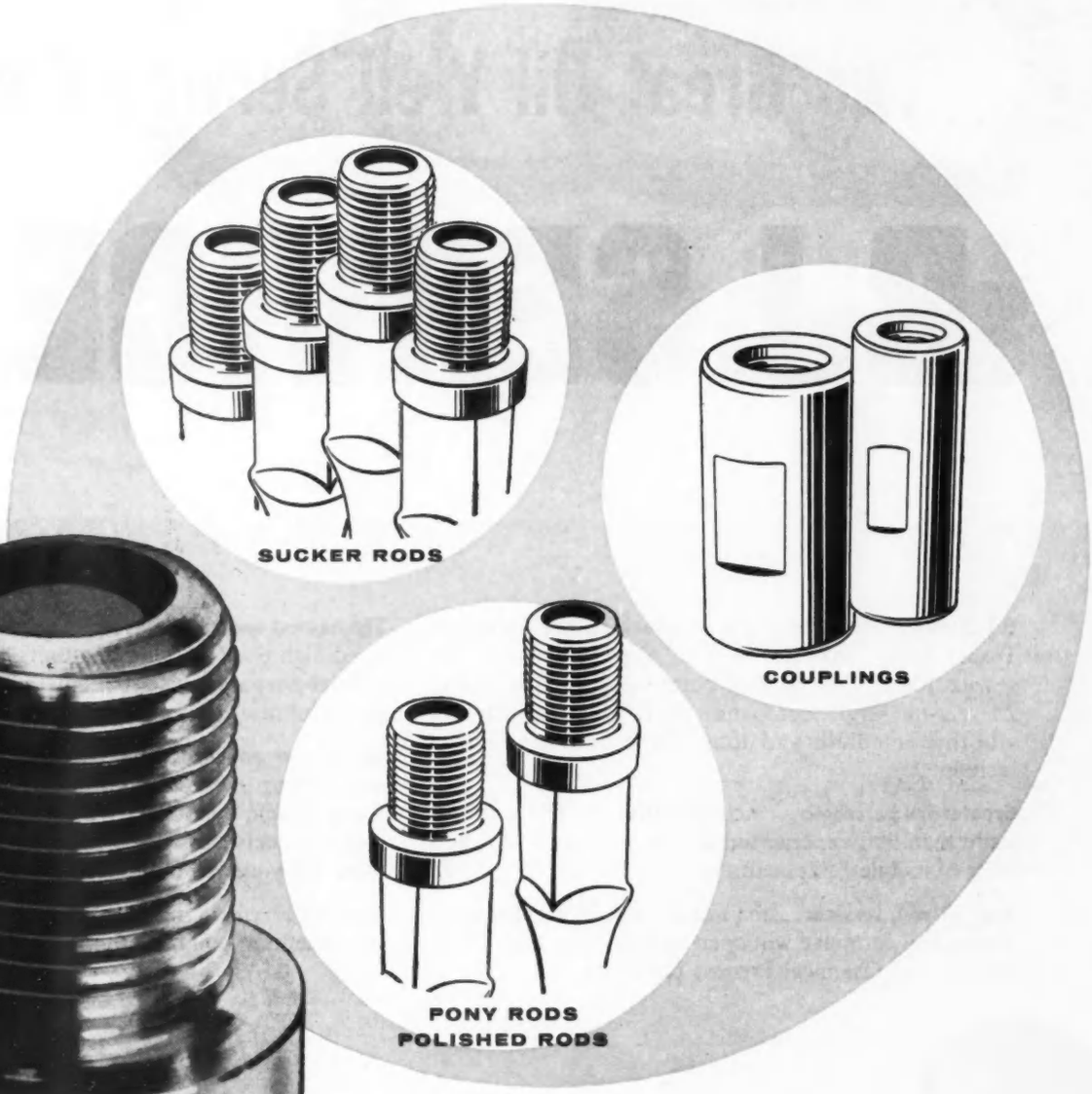

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Greater field strength... including fifty-six field stations, more than 900 experienced service personnel and 800 units of mobile equipment.

New oil well services... the interchange of service techniques and formulae will open new services both to BJ Service and Chemical Process customers.

The newest and most powerful equipment... newly-developed high pressure pumping units and newly-perfected special-purpose tools are ready to be introduced by this powerful new service partnership.

Great new advances in research... two major research and testing laboratories at Breckenridge, Texas and Long Beach, California will coordinate their development projects on service techniques, tools and equipment for your job improvement.

Greater *service*... more efficient *processes*... these are the benefits to you from this important new partnership!

John B. Merritt, executive vice president of BJ Service, and R. G. Miller, executive vice president of Chemical Process, shake hands and join forces in a powerful new oil well service organization.

BJ SERVICE

Since 1928, this company has been a pioneer in oil well cementing services, and is recognized as "the company that put quality competition into the business." In addition, it is also recognized as a leader in the field of perforating. *Service* is its middle name.

CHEMICAL PROCESS

Since 1932, this company has been a pioneer in well stimulation service. C.P. developed Permeter service, blocking agents and other services with which the company augments fundamental acidizing and fracturing procedure, plus a personnel which applies more than 2,000 man-years of experience to these operations, add up to complete, progressive, top quality well stimulation service.

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cessive operation of a compressor, this of course reduces unnecessary compressor wear as well as horsepower requirements.

Piping. It is inconvenient for a manufacturer to transport a unit in a completely assembled package. It is the general practice to ship the unit as several sub-assemblies requiring auxiliary piping and bolting at the well site.

It must be emphasized that whether the piping is supplied by the manufacturer or the operator, it must be kept clean. Should foreign matter become lodged within one of the valves a malfunctioning unit may result.

MAINTENANCE

Filters. Most manufacturers provide filters installed and engineered to keep the hydraulic oil clean. A non-counterbalanced unit may be equipped with a suction strainer leading into the pump. An air breather on the fluid tank prevents sand and dirt from settling in the oil reservoir. These two filter types are considered to be re-useable and require only periodic cleaning. The intervals between cleaning depend on the ambient conditions. Until experience dictates a schedule, it would be advisable to clean every 30 days. The filters may be cleaned in a solvent and dried with an air blast.

The larger counterbalanced units are equipped with a bypass-type filter. They operate from the auxiliary scavenger pump, filtering 3 to 5 gallons per minute. These filters are of the replaceable pack type. Replacement of these packs may be determined by the pressure gage, located on the filter unit. For example; at the time of initial unit operation the gage may read 10 pounds per square inch. As the filter performs its work, foreign matter will become incased within the pack, restricting fluid flow appreciably. This restricted flow will be indicated by a gradual increase of pressure gage reading. The pressure will eventually increase sufficiently to operate a safety valve, thereby bypassing all filterable fluid. Filter pack replacement should be accomplished prior to this final high pressure reading.

Some installations warrant use of a secondary filter of the waste rag type. Here again, experience will dictate the cleaning schedule. The waste is merely replaced by a fresh rag.

Stuffing Box. A manually loaded, as well as a spring loaded stuffing box is successfully used on hydraulic units. Provisions have been made to use the maximum spring compression initially, as the packing wears the spring will continue to supply sufficient force to prevent fluid leakage. The packing eventually requires replacing at which time the spring is again fully compressed.

The manually-operated stuffing box should be tightened until a full fluid seal exists, then, backing off slightly to allow lubrication of the polished rod. Continual packing adjustment and additional maintenance is required for this type stuffing box, however, longer packing life is gained over the spring loaded type.

Oil Temperature. Operating oil temperatures are indicative of the power put into the unit. As the temperature mounts, so must the time schedule for maintenance. Filters clog more rapidly, due primarily, to an accumulation of sludge; stuffing box leakage increases due to the oil being less tenacious or of lower viscosity. If the operating temperature is 170° or over one should expect considerable valve maintenance. Close tolerance valves are considered "hot spots" in hydraulic equipment and are likely locations for the formation of sludge.

Coolers are available to cool the oil and hence, prolong oil life and reduce the rate of sludge formation.

Jackshaft. The majority of units are equipped with "V" belt drives for operating the power pump. This is economically feasible through the use of a jackshaft or auxiliary shaft, which is supported by radial load bearings and is connected to the pump by a coupling. The bearings and coupling, if flexible, should be lubricated periodically. The manufacturer can supply the proper lubricant specifications.

A high and low oil level check should be scheduled for units having the jackshaft completely enclosed. A premium type lubricating oil similar to that used in engines is recommended.

The open-type jackshaft requires more frequent inspection and lubrication to avoid excessive heat and wear.

Vee Belts. A periodic check should be made on the main auxiliary belt drives. Proper tension will lengthen belt life appreciably. Loose belts slip and generate heat with resulting accelerated belt wear. In addition, slippage must be accounted for in an increase of applied horsepower.

Tension of belts depend upon the type used; standard duty, super duty or steel cable. Standard and super duty belts will stretch under use, but steel cable will not. Consequently, shortly after the former belts are in operation a secondary adjustment must be made. After the initial stretch has been accounted for, subsequent belt adjustment will be minor. The steel cable belt should never be required to operate with an initial tension as great as a standard or super belt. It is recommended that steel cable belts be used only when absolutely necessary.

Gages. Gages are provided for visual inspection of operating loads and/or pressures at various points on the unit. The service life and accuracy of these gages may be appreciably extended if valves leading to the gages are kept shut and opened only for a periodic reading. Disassembly of a pressure gage should be done by experienced personnel only.

Cleaning. Regardless of the care taken in maintaining clean hydraulic oil, eventually replacement will be required. A new charge of oil should never be put into the system without first purging the complete circuit with a fluid cleaning compound. Then, after completion of the flushing program all auxiliary tubing lines should be disconnected and steam cleaned. Although time consuming the procedure will prove advantageous by providing a maximum service life of the new oil. The cleaning program also should provide new filter elements.

Compressor Piping. Air, taken into the compressor at atmospheric pressure, is boosted to the counterbalance pressure. The ambient air contains moisture which breaks out from the compressed air in the forms of droplets. This has been anticipated by the manufacturer and water traps are strategically located on the unit. These traps should be vented daily to reduce the possibility of water entrapment within the hydraulic circuit.

ACKNOWLEDGMENT

Presented at the West Texas Short Course—Oil Lifting Methods, Texas Technological College, Lubbock, Texas.

—The End

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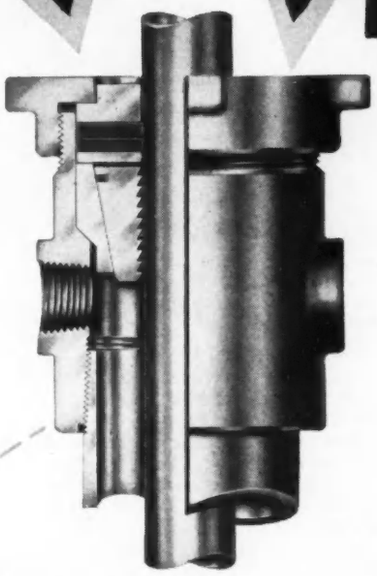

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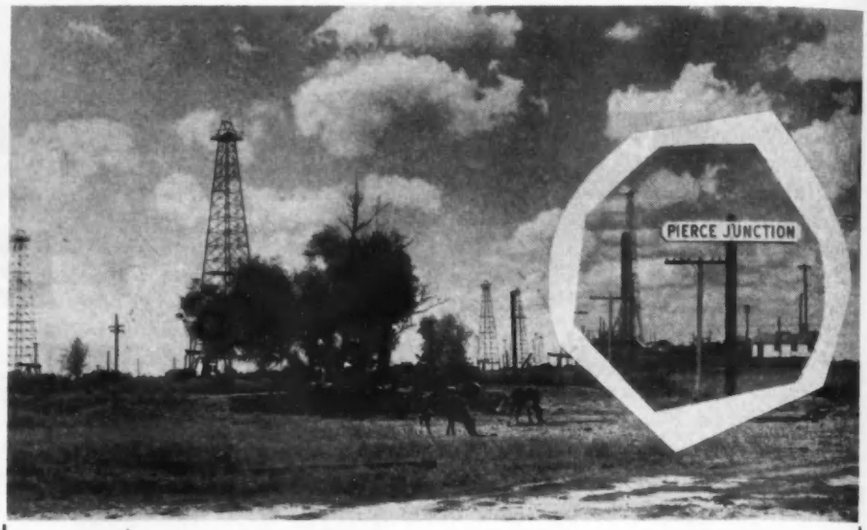


All Is Peaceful at Pierce Junction

IN SEPTEMBER WORLD OIL was a letter from "Sidney Strong," addressed to "Paul Peebles." For the benefit of those WORLD OIL readers who have been born since the early 1920's, Paul Peebles was a mythical Goose Creek "Bollweevil" who tried to associate himself with the scientific men of the oil industry, and whose letters to his boarding house sweetheart, Cleo, at Goose Creek found regular space in *The Oil Weekly*. Paul was generally short on spelling (having won the championship in the South Texas free style spelling contest) but he was long, or thought he was, on his facts. Paul is still on the WORLD OIL staff although his letters have not appeared in it for a long time. Now he rises to correct some "falts" accusations made about his correspondents. His letter in reply to Sidney Strong (who incidentally is a very eminent geologist in the oil business) follows:

Mr. Sidney Strong,
dere Old Sid:

Well I find you come out of your hiding long enuf to tell me and my assycociates what's what. I am a consulter for WORLD OIL on scientific and other matters and Sid I hate to tell you you are barking up the rong tree and making falts accusations when you tell the boys they don't no how to spell that there oilfield right South of Houston. I guess, tho, Sid, that maybe these here assycociates of mine air living in a diffrunt age from you on account of they figgers that when the county sets up a road sign the county ort to know what it is talking about and Sid, old Pal, there is a sign as plane as can be right at the field whitch says

PIERCE JUNCTION

. I no that it is important to name anything right, Old Pal, but don't you go a saying that my assycociates air sitting on there you no whats when they air very busy and Sid, if you reely want to get everybudy straitened out on spelling Pierce or Peirce Juntion, you will haf to right to the county judge and commishuners of Harris county where "Pierce-Peirce" Junction is, and you'll now have to right the Mayor of Houston (on account of the city has a part of the feeld inside of its limitatiions, and you'll have to right the Texas Hiway Commishun, and a helluva lof of other fellows on account they all spell it the way my assycociates spelt it.

Sid, will you come agin on the date of that issue of *Oil Weekly* whitch had the story by Wayne Bowman on account we don't find nothing by Wayne in the issue you named.

Now Sid, I am mighty glad to here from you and hope you will excuse my taking on m own typerighter into hand to give you this persumal answer. You and I have seen a lot of water go over the dam sints we was together and if you ever get away from Fort Worth long enuff to get to Houaton, I'll buy you a old time meal whitch I think my boss will let me put on the expents account.

Yore true frien,
Paul Peebles

Northwest Canada. Oil and gas exploration and drilling activities are being stepped up in British Columbia.

Phillips Has a Big Stake in British Columbia Operations

Large natural gas reserves have been established, and negotiations are under way to sell gas to pipe line companies. Exploration and drilling are continuing on company's extensive holdings.

By **ANTHONY GIBBON,** World Oil Staff

During the past decade, Canadian crude reserves have increased from 200 million to the mid-1956 total of 3 billion barrels. Gas production also has increased and the future of the gas industry in Canada seems assured. U. S. money and know-how has made a signal contribution to this dynamic development.

While the full impact of development was centered in the Province of Alberta following the Leduc strike, oil men—Canadian and U. S. now are moving westward.

Today, British Columbia looms as Canada's newest oil and gas frontier.

The spearhead of development has been delayed by the long distances to supplies and product markets and inadequate transportation.

But today, the picture is changing rapidly.

At Fort St. John, giant pile drivers have hammered footings for a railroad trestle across the Peace River. The Pacific and Great Eastern railroad is building a line north from Prince George to Dawson Creek and Fort St. John. Upon its completion these cities will have rail outlets to the Pacific Ocean.

Dawson Creek, in British Columbia, is the starting point for the Alcan highway built by the U. S. Army during World War II to supply its Alaskan outposts. This highway, stretching 1528 miles northwestward to Fairbanks, Alaska, has opened the far north to auto travel.

At Fort St. John, some 50 miles along the Alcan highway, can be seen the $153 million natural gas pipe line being constructed by Westcoast Transmission Company, Ltd. This major artery, when completed, will deliver natural gas to Vancouver and other cities and towns in British Columbia, as well as to the Pacific Northwest Pipeline Corporation at the U. S.-Canadian border.

Among the most active American operators in British Columbia is the Phillips Petroleum Co. An exploratory well on its wholly-owned 29,000-acre Kobes Creek block already has discovered four gas zones capable of producing 70 million cubic feet of gas per day. A second well is being drilled on this promising acreage. Close by, Phillips is earning an interest in the 29,500-acre Townsend block by drilling the first of two exploratory wells. Successful development of these blocks will result in a substantial increase in British Columbia's gas reserves.

In preparing to drill on the Kobes Creek and Townsend blocks, Phillips engineers encountered a unique situation. The road to the locations, they found, winds through the Beaver Indian reservation. Efforts to obtain permission to cross the Indian land were fruitless. Chief Sammy Fox declined to enter into the usual right-of-way contract.

Negotiations bogged down until the Indian agent suggested using flour instead of money. This proved satisfactory and each member of the tribe was given a 50-pound sack of flour. Phillips personnel then was permitted to pass unhindered through the reservation.

To get to well locations in Kobes Creek and Townsend, Phillips uses a 26-mile road which starts between mileposts 95 and 96 on the Alcan highway. Much of this road was cut around treacherous muskeg areas. Moving heavy equipment is difficult during the summer months even on

Rugged men and equipment are required to negotiate oil field roads such as this in the Peace River country of British Columbia.

Phillips Petroleum Co.'s Savanna Creek 3-A, 60 miles southwest of Calgary, is atop a mountain where icy winds reach up to 100 miles an hour in winter.

improved roads. Huge tractors sometimes "drop out of sight." Dragline retrieving is a standard part of muskeg country operations. Road beds are built wide and trees cut back so the summer sun can dry the roads.

Winter operations in British Columbia are rugged. Snowfall is heavy and the whole country freezes over. Temperature sometimes drops to 60° F. below zero. But drilling continues the year round. Rigs are walled in and heated, and crewmen work in comparative comfort. To assure continuous operations, extra supplies, spare parts and equipment are stored at the location.

One of the most important and significant developments for Phillips in its British Columbia operations is its agreement with Canada Southern Petroleum, Ltd., whereby Canada Southern has farmed out to Phillips a 1.3 million net acre interest in approximately 2 million acres of Crown exploration permits in the Peace River area. Canada Southern reserved a net profit interest in the acreage.

The Canada Southern acreage contained about the only sizable blocks available in northeast British Columbia. The holdings are in strategic lo-

cations with respect to other Phillips operations and offer opportunities for the discovery of oil and gas.

Under terms of its agreement with Canada Southern, Phillips will drill exploratory wells and also undertake an extensive geological and geophysical exploration program to evaluate the oil and gas potential of this extensive area.

Canada Southern already has made a gas discovery on a structure in the area and Phillips is now drilling on the proved structure. Rig site is northwest of Fort St. John near Alcan milepost 122, approximately a mile and a quarter northwest from Canada Southern's discovery well.

Phillips has a big stake in British Columbia. Large reserves of natural gas have already been established and negotiations are under way to market the gas to pipe line companies. Exploration and drilling continues on its extensive holdings in this province.

In addition to its energetic campaign in British Columbia, Phillips is active in other areas in Western Canada.

Phillips has approximately 2.7 million net acres in Canada, mostly in British Columbia, Alberta and Saskatchewan. To take care of increased exploration and drilling activities in these areas, additional personnel and office space have been added to the company's new Calgary, Alberta, headquarters located in the Hudson's Bay building.

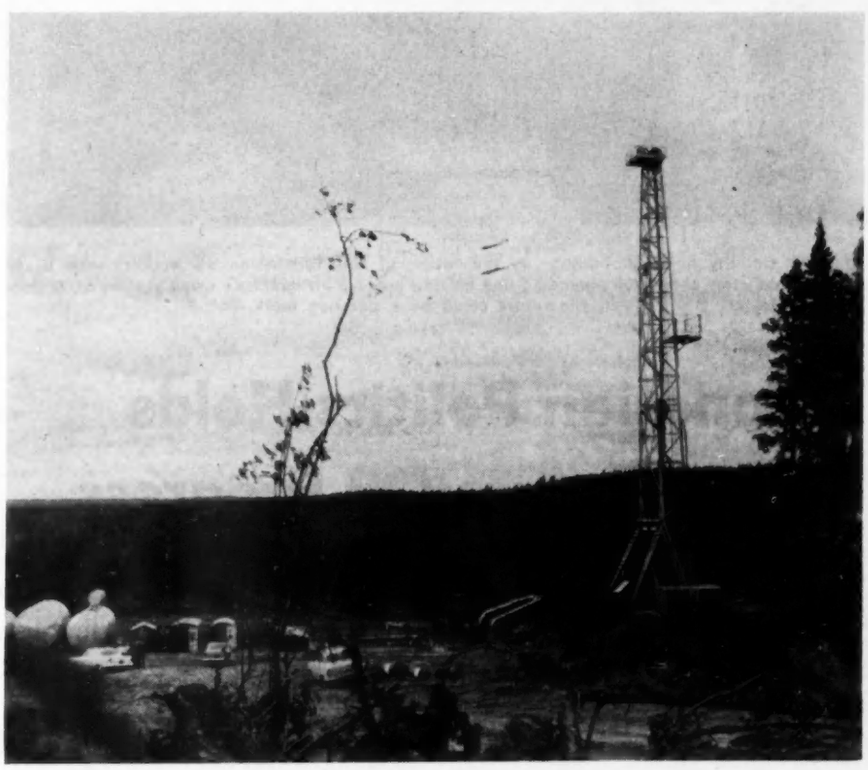
In Alberta, Phillips has been very successful.

Approximately 60 miles southwest of Calgary on the partly-owned 78,000-acre Savanna Creek block, a gas discovery well has been tested at the cumulative rate of 50 Mmcf of gas daily based on separate tests of four zones. Savanna Creek 2-A also is a commercial producer and well 3-A is drilling. This well is located on a mountain top where icy winds attain 100 miles an hour and temperatures drop as low as 50° F. below zero during the winter.

But, as in British Columbia, crewmen have housing and equipment to combat the weather, and drilling continues throughout the year. A fourth well, the Salter A-1, has been located. The Savanna Creek field promises to develop into one of the best gas fields in Canada and it is well within the reach of proposed pipe lines.

Phillips also has oil production in other sections of Alberta—principally in the Joffre and Westrose pools, and now is drilling on proven acreage at Pembina and South Sturgeon Lake. An exploration program is under way on additional Crown lands.

Modern trailer camp houses Loffland Brothers drilling crews in the Savanna-Creek gas area southwest of Calgary.



Canada Southern Petroleum Ltd.'s Highway 2 well on a newly-discovered gas structure northwest of Fort St. John, British Columbia.

ACKNOWLEDGMENT

The author thanks Phillips Petroleum Company and Charles E. Cummings, editor, *Philnews*, for information and pictures included in this article.

Political stability holds the answer to the future of this Indonesian oil worker: with it, his industry has every chance of expanding and helping improve his country's living standards; without it, the future could be a question mark.

Indonesian Politics Holds Key to Future Oil Progress

Government seeks long-term loans with no strings attached to correct deficit financing and to develop its natural resources.

By H. T. BRUNDAGE
WORLD OIL Staff

OIL ACTIVITY in Indonesia since the close of World War II has been largely restricted to repairs and rehabilitation of pre-war fields and facilities damaged during hostilities without the development of any outstanding additions to reserves through exploratory work. A big factor in the moderate rate of postwar oil development in Indonesia has been the unstable political situation. The new Republic of Indonesia continues to suffer from a continual internal struggle for order. Each succeeding government has been unable to last long enough to see its program, no matter how constructive, reach fruition.

Private capital, so badly needed in the potentially rich but retarded archipelago, is unable at present to assess its own position. This is because with such a confused political situation, it has been difficult for any government to formulate lasting policies which might allow sufficient private capital to be invested in Indonesia with confidence.

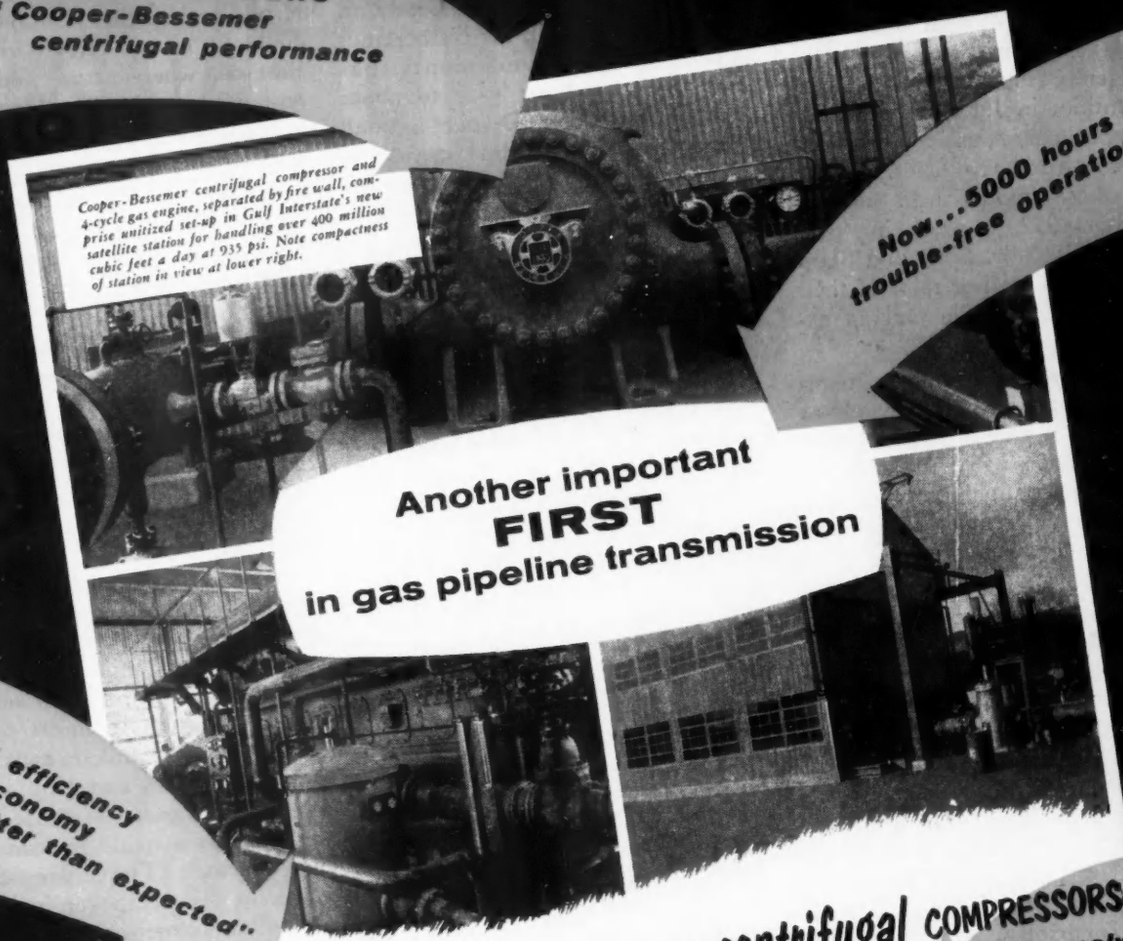
Indonesia has been a confirmed oil province for over 60 years. Royal Dutch Shell found commercial oil in 1893 at Telaga Said Darat in North Sumatra on a surface structure. And 51.5 gravity paraffin-base oil was produced from the Grensklei sand at depths of 720 feet and shallower. This one field produced almost 24 million barrels before World War II. The North Sumatra concessions, including Telaga Said, Perlak, Rantau, and at least five other fields have not been returned to Shell. Instead, this concession, including the Brandan refinery, is being operated on a limited scale by a national company formed by and as an integral part of the Indonesian government.

North Sumatra is, indeed, a composite situation from which most of Indonesia's current major troubles may be viewed, and, to a large extent, understood. There, the government is trying to run the oil fields and the refinery, both badly damaged during hostilities, with limited capital, equipment, and technical personnel. Also, there is intermittent civil unrest, as the Achinese, a Moslem tribe of North Sumatra, have traditionally resisted any government other than their own local regimes.

1955 Production. Last year, crude production in Indonesia by the three private companies operating there—Royal Dutch Shell, Standard-Vacuum Oil Company, and Caltex Pacific Petroleum Company aggregated about 86 million barrels, with the Shell group producing 45 percent of the total.

Shell's current production is from fields in Kalimantan (Indonesian Borneo), Sumatra and Java. Twenty-

Here's LATEST NEWS of Cooper-Bessemer centrifugal performance



Cooper-Bessemer centrifugal compressor and 4-cycle gas engine, separated by fire wall, comprise unitized set-up in Gulf Interstate's new satellite station for handling over 400 million cubic feet a day at 935 psi. Note compactness of station in view at lower right.

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one of Shell's fields were on production last year. Stanvac, since 1933 the operator of production which was found by one of its two parent companies, Jersey Standard, in commercial quantities in 1922 in South Sumatra, produces about 70,000 barrels daily from Sumatra fields. Caltex Pacific, whose production in Sumatra dates from 1952, is producing over 70,000 barrels daily. Shell and Stanvac refine locally all or most of their Indonesian crude, while Caltex exports its crude.

All privately-owned Indonesian refineries are running approximately at capacity, and it may be inferred generally that refinery expansion and new construction await final resolution and clarification of governmental attitudes toward private capital.

By contrast, Royal Dutch Shell's development and extension of fields in politically-stable British Borneo (Sarawak and Brunei) has recently resulted in crude production exceeding 100,000 barrels daily. The Lutong refinery is running at capacity of 50,000 barrels daily, and a new gas-processing plant went into operation in nearby Seria field last year. Most important of all, a new wildcat discovery was made in 1955 near Brunei town at Jerudong. And the Shell group was proceeding to develop the offshore possibilities of British Borneo.

Generally, Indonesian oil should have a good future. WORLD OIL's cumulative production figures show that 1.6 billion barrels had been produced in Indonesia from 1893 through the end of 1955. Indonesia has been fairly thoroughly explored for oil onshore.

How much oil remains to be discovered is, of course, questionable, but one authoritative evaluation is that one-half of Indonesia's onshore oil has been found and perhaps one-fifth of it has been produced.

Most of Borneo's interior has been mapped by Royal Dutch Shell geologists. Surface rocks there indicate that all but certain coastal areas of the big island will be barren oil-wise. Some prospective areas in Java and Sumatra remain to be drilled. Additional exploration and drilling is expected in Celebes, parts of which have a favorable Tertiary section. Commercial asphalt deposits, always a "red flag" for oil hunters, occur in southern Celebes.

Drop in New Guinea. Production in Western New Guinea, currently an area claimed by both the Netherlands and Indonesian governments, has dropped in the past year to about 9000 barrels daily. Despite a small wildcat discovery made last year at Selehin Vogelkop, exploration results in Western New Guinea have been disappointing. Nederlandsche New Guinea Petroleum Mij (NNGPM) is composed of Royal Dutch Shell, Stanvac, and Caltex interests on a 40-40-20 percent interest basis, respectively.

All production in the archipelago is from Tertiary beds. Most of the production is from Miocene and Pliocene. The pre-Tertiary is considered to be basement. Below the Tertiary, volcanic rocks and, usually, high bottom hole temperatures are encountered.

Royal Dutch Shell's deepest production is in Kalimantan at Bunju, as deep as 7850 feet, but the rest of its production is shallower. Caltex Pacific's deepest Sumatra test was drilled at Kota Batak to 5542 feet. In this well, the pre-Tertiary was topped at 5030 feet. Evidently drilling was pursued thereafter only long enough to determine beyond question that the well had permanently entered basement rocks.

Beyond Indonesia to the north, Tertiary basins also represent the prospective areas in the Phillipines and in Taiwan. To the south and east, Timor is not considered very prospective because highly disturbed and partly metamorphosed Mesozoics (mostly Triassic) occur at the surface of much of the island.

Offshore Oil. Indonesia's offshore oil possibilities may have great merit. Almost nothing has been done to evaluate them, but in the distant future, reserves may be found off Sumatra, Borneo and Java and the area in between. The marine waters common to these three big islands nowhere exceed 600 feet in depth, and usually the sea floor is much shallower. Indeed, all faunal, anthropological and other evidence indicates that in recent geological times these islands were all connected with the southeast Asia mainland.

It is possible that a sizable offshore area will be available for drilling by the time onshore prospects become so picked over and production so depleted that Indonesia will look to its shallow marine areas for new sources of oil. But whether such oil, if found, could be competitive with Middle East oil, where actual and potential onshore reserves should last at least through the end of this century, is questionable.

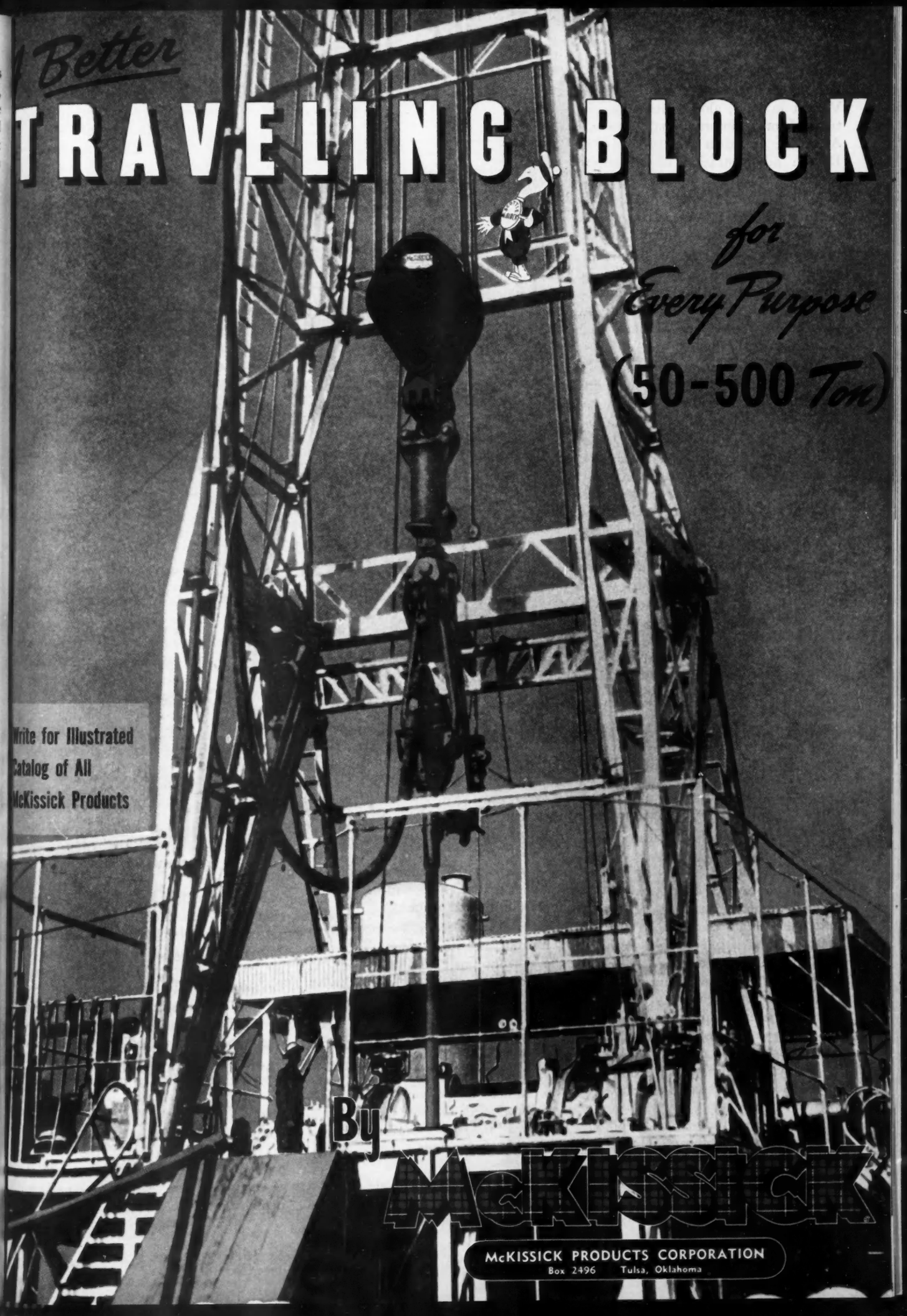
Indonesia's total land area is variously estimated from 583,000 square miles up to 740,000. There are about 80 million people, and 52 million of them live on Java, where more than 1000 people are crowded into the average square mile. The actual number of islands included in the Republic is indeterminate, depending on whether an island is defined as a rock protruding from the sea, and whether only areas with vegetation and/or inhabitants are counted.

Indonesia probably has between 1000 and 2000 inhabited islands. The Indonesian part of the archipelago is more than 3000 miles long in the east-west direction, and 1300 miles from north to south. About 94 percent of the people are Moslems but there are many Christians and Hindus, with a number of separate sects. Much progress has been made in standardizing the language. There are about 200 different dialects spoken in Indonesia, and all are somewhat similar.

The nation's history includes a large number of invasions, sometimes peaceful, more often forceful. East Indian culture predominated prior to the thirteenth century, but it was largely superseded after a Moslem infiltration at that time which resulted, among other effects, in conversion of most of the Hindus.

However, in some localities, notably on Bali, Hinduism remains as the dominant religion, and the influence of Hindu culture still is quite important. Chinese have settled in Indonesia in a number of waves from time to time. There are now 3 million Indonesian citizens of Chinese descent. Generally, however, the Chinese are well integrated into Indonesian society and have even been represented in the cabinet. They represent a large segment of the Indonesian mercantile class, being particularly prominent in banking circles.

During and after the European Renaissance, the Indies were the scene of a series of contests, with Dutch, British, Portuguese, Spanish, and, to a lesser extent, French traders vying for position in lucrative East Indies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shipping. Much of this strife was settled upon conclusion of the Treaty of Vienna in 1814, along with a multitude of other international disputes. After the London treaty of 1824, Dutch administration of Indonesia continued until the Japanese occupation in 1942. In 1945, with the departure of the Japanese, Indonesia proclaimed itself independent.

In view of such a long history of outside interference, it is small wonder that Indonesia longs for autonomy. But it is equally unfortunate that such an unwieldy geographical and political situation exists.

The independence movement was formally initiated early after the turn of the century. Then, in 1920, Partai Komunis Indonesia (PKI), the Communist party, was formed. The Dutch had little use for this particular movement, and after some violent PKI terrorism, 4500 members were arrested in 1926 and 1300 hard-core Communists were sent to the Digul, New Guinea, concentration camp.

But the Dutch frowned upon certain other movements toward independence, which they considered premature and jailed—and later interned—both Achmed Sukarno, who founded PNI (the Indonesian Nationalist Party) in 1927, and his colleague, Mohammad Hatta. Both were liberated by the Japanese in 1942. Sukarno and Hatta are highly respected by the Indonesian people, and their internment tended to make them martyrs in the eyes of Indonesians.

Following the 1945 proclamation of Independence by Sukarno, the Dutch requested negotiations, and, in the belief that Indonesia is not equipped for total autonomy, offered to put Indonesia on equal status with the mother country in a federated union under the Dutch crown, with all citizens to enjoy a privileged position when in the other's territory. Negotiations broke down twice during 1946-1948, and both deadlocks were followed by military police actions by the Dutch in parts of Indonesia. Pressure brought to bear on the Dutch by the United Nations was heeded, and troops used in the second action were withdrawn.

In 1949, the Indonesian Republic won its independence from The Netherlands by a treaty signed by both, with each party agreeing to grant special privileges in their territory to the other's citizens. This treaty was unilaterally abrogated by the Indonesian government early in 1956, following the conclusion of its election.

1956 Election Returns

PARTY	Popular Vote	Number of Seats in Parliament
PNI (Nationalist)	8,434,653	57
Masjumi (Moslem)	7,903,886	57
NU (Orthodox Moslems, or Moslem Teachers)	6,955,141	45
PKI (Communist)	6,176,914	39
PSII (United Moslem, or Moslem Union)	1,091,160	8
Parkindo (Christian or Protestant)	1,003,325	8
Katolik (Catholic)	770,740	6
PSI (Socialist)	753,191	5
IPKI (ex-Army officers)	541,306	4
Perti (Moslem-Sumatra)	483,014	4
(18 minor parties)	2,649,000	24
Other votes	1,022,969	0
Total	37,785,299	257
Number of registered voters	43,104,464	
Seats allowed to West Irian (West New Guinea, disputed territory)		3
		260

	Seats for Java	Percent of Party Represented	Seats Outside of Java	Percent of Party Represented
Masjumi	28	49	29	51
PNI	45	79	12	21
NU	37	82	8	18
PKI	35	90	4	10

The Masjumi Party is a Moslem group, somewhat western oriented in its sympathies. Ex-Premier Harahap is one of Masjumi's most prominent members. The Masjumi is strongest in the other islands, as is evident from the election statistics.

The N. U. (Nahdatul Ulama) is a party led by Islamic scholars and priests. They are almost strictly Asiatic in their thinking and aloof from western ways. The N. U. showed surprising strength in the elections. The PKI (Communist) vote is dangerously large; but, as in France, it represents, in large part, protest votes. None of the other major parties cares to have PKI participation in the cabinet, and it appears that there will be no such representation at present.

It is obvious from the election results that any government, including the current one, led by Premier Ali Sastroamidjojo, will have to be a coalition. Further, that with so many different factions and splinter parties, it is difficult to achieve even a fair degree of unity.

However, there are bright spots, too. Almost 88 percent of the registered Indonesian voters voted, and in the great majority of cases, quietly and without incident.

Problems Plentiful. Today, Indonesia is faced with a multitude of problems over and above the lack of unity and of leadership. It has an overstaffed and inexperienced bureaucracy. Intermittent civil war continues in North Sumatra, in parts of Celebes, Borneo, and Java. The government, without adequate monetary reserves, has been indulging in deficit financing and only recently has succeeded in arresting a serious inflationary trend. Indonesia needs capital, not only for development of her oil, but of many other products, including bauxite, tin, coal, cement, gold, silver, nickel, manganese, iron, rubber, quinine, etc.

In mid-July, 1956, the Indonesian government made public a request for long-term loans on a no-strings-attached basis. Details of the invitation were scheduled to be announced.

There are two ways, however, that Indonesia might improve its chances of acquiring more help from Western nations:

- The unilateral abrogation of their 1949 treaty with the Dutch may give Western investors pause. Generally, Indonesia has a good reputation for honoring its obligations on a business level, including its financial obligations to the Dutch. However, Westerners view the treaty abrogation as an unhealthy precedent, even though it is on a strictly governmental level. Indonesia might consider allowing the Court of International Justice to judge its disputes with the Dutch concerning the 1949 treaty and West Irian (West New Guinea), since this court seems as competent to weigh the cases as any other.
- If Indonesia wishes the Western world to appreciate fully its good attributes, it might consider giving credit to Westerners where credit is due.

Recent writings in a U. S. publication state that the Dutch performed virtually no public works in Indonesia. Actually, among other things, the finest systems of roads and rural electrification in the Far East, with the exception of those in Japan, were built by the Dutch in Java. In addition to putting an end to local, feudal wars in Java, the Dutch forced the Javanese to make their roofs of tile, not of thatch. The Dutch were ruthless about doing away with thatched roofs. Those thatched roofs provided built-in rats' nests, and bubonic plague, carried by the rats, was the principal reason why there were only 2 million people on fertile Java in 1800.

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What's Happening

AMONG WORLD OIL MEN

J. H. LOUDON has been elected a director of Shell Oil Company. He is general managing director of Royal Dutch Petroleum Company and chairman of Shell Caribbean Petroleum Company. In his new post Loudon succeeds DR. H. BLOEMGARTEN, who has retired.

J. H. Loudon

•

FRED T. BOONE, formerly with Kuwait Oil Company and now a toolpusher with California Texas Oil Company, recently visited Houston, Texas, on a tour of oil field installations en route to Indonesia, where he will be headquartered at Rumbai oil field.

•

CHES M. HARDEN and G. R. OLSEN have been assigned to Venezuela by Pure Oil Company following award of a 28,000-acre concession in Lake Maracaibo to a group composed of Pure, Signal Oil and Gas Company, Hancock Oil Company, and Standard Oil Company (Ohio).

Harden has been named general superintendent of drilling and production for the four-company group, and Olsen will serve as senior production engineer. They will work under GARTH L. YOUNG of Signal, who has been appointed general manager of the group's Venezuelan operations.

After joining Pure Oil in 1934, Harden became assistant general superintendent of the company's Van field operations in Texas. From 1937 to 1946, he supervised the drilling of more than 2000 producing wells for Pure Oil in the Illinois Basin area. For the past ten years, he has been general superintendent of the company's Rocky Mountain producing division.

Olsen, a Purdue engineering graduate, gained offshore experience in the company's tidelands operations and also served with the Rocky Mountain producing division. Since 1953 he has been assigned to company headquarters in Chicago as a senior production engineer.

Frank Manning, who joined Pure at Sweet Lake, La., in 1927 as a derrickman, has been appointed to succeed Harden as general superintendent of the Rocky Mountain division. Manning served the company as superintendent of rotary tool operations at the Worland field in Wyoming from 1946 to 1955, when he was placed in charge of exploratory drilling operations in Canada.

•

LLOYD G. SMITH, vice president and director of Creole Petroleum Corporation, retired after 43 years service. He started his career in 1913 as a draftsman at the Whiting Refinery of Standard Oil Company (Indiana), transferred to Casper, Wyo., in 1922 as a foreman. Later, he fulfilled several posts with Pan American Petroleum and Transport Company and became part of the Standard Oil Company (New Jersey) organization when Pan American's foreign properties were bought by Jersey in 1932.

L. G. Smith

•

R. D. ROBERTS, formerly Mid-Continent division geophysicist for Sohio Petroleum Company, has been promoted to manager of Sohio's new 100 percent Sohio office in Calgary, Alberta, Canada. In his new post, Roberts will supervise all activities of the new office.

•

Eleven geologists of The Ohio Oil Company have been transferred to the company's subsidiary in Libya, the Oasis Oil Company of Libya. Oasis of Libya is the operator of Libyan concessions totaling about 35 million acres, which are owned jointly in undivided one-third interests by Ohio, Continental Oil Company and Amerada Petroleum Company.

Oasis of Libya will maintain offices in Tripoli and Benghazi.

The geologists are:

JAMES A. CARTER, JR., formerly of Wichita, Kansas; PRESLEY L. DeJARNETT, Coalinga, Calif.; DONALD M. DePRIEST, Sidney, Neb.; WILLIAM A. FOWLER, Evanston, Wyo.; JOHN O. GOFFE, Cody, Wyo.; WARREN C. HEISTERKAMP, Durango, Colo.

ROBERT M. HILES, JR., Rawlins, Wyo.; WILLIAM G. NOONAN, Abilene, Texas; JOHN L. REDMOND, Calgary, Alta., Canada; DEL L. WIEGAND, Rapid City, S. D.; and JOSEPH C. WILSON, Liberal, Kansas.

•

JOSEPH TAYLOR FLY, general counsel and a director of Creole Petroleum Corporation, Caracas, Venezuela, has retired. Long associated with Latin-American petroleum and legal affairs since 1920, Fly joined Creole, Venezuelan affiliate of Standard Oil Company (New Jersey), in 1942 and was previously a member of Jersey Standard's Latin-American legal staff from 1935. Fly is a member of the Venezuelan Chamber of Commerce, Bolivarian Society, and the Pan-American Society.

•

NORMAN HARDY, vice president of Arabian American Oil Company has been elected executive vice president. He started his oil business career in 1926 as a geologist with Standard Oil Company of California, served in several overseas and domestic posts until he joined Aramco in 1951. Hardy continues his location at Dhahran, Saudi Arabia.

N. Hardy

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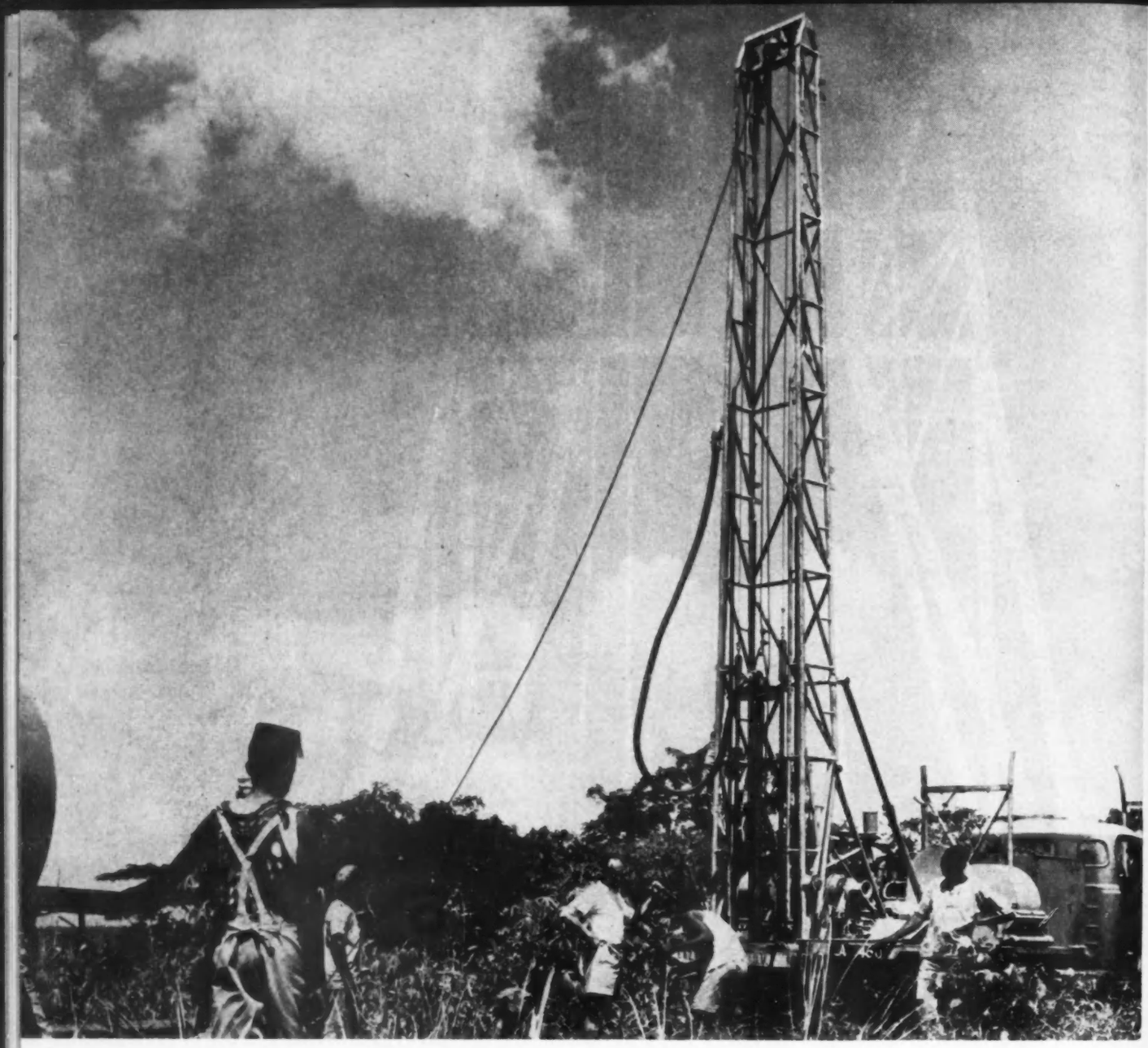

This seismic survey party of The British Petroleum-Shell Petroleum Development Company of Tanganyika is operating a drilling outfit at a refraction shot point on Zanzibar Island, off the coast of East Africa.

BP-Shell Joint Zanzibar Test Is Drilling Ahead

Projected 12,000-foot test, area's second well since oil search began in 1951, staked out after 18 months of intensive geological and geophysical operations.

OPERATIONS ARE continuing on the first well ever to be drilled in the search for oil on the island of Zanzibar, off the coast of East Africa. This wildcat, which is a projected 12,000-foot test, is the second deep test well drilled in East Africa since exploration started in the area in 1951. The first exploratory test, completed on Mafia island early in 1956 at a depth of 11,051' feet, was a dry hole; however, it did yield valuable geological information.

The Zanzibar test, being drilled jointly by The British Petroleum Company and the Royal Dutch/Shell Group was spudded in after intensive geological and geophysical surveys during the past 18 months.

A special jetty had to be built where all required equipment could be brought by ship and unloaded. Roads were constructed from the jetty to the drilling site, and houses were erected for 300 workers.

Further, the operation will require 200,000 gallons of fuel, 700 tons of cement, 24,000 feet of casing, 1500 tons of mud chemicals, 10 million gallons of water, and 600,000 kwh of electricity.

Above—Crew members plug their ears as a 'shot' explodes.

Left—This geophysicist is reading a gravity meter at a station in the village square of Zanzibar.

Right—The search for oil in East Africa includes road-building operations. Here, quarrying is under way for material used in the construction of roads and jetties being built by The BP-Shell Petroleum Development Company at Zanzibar.

a WORLD of OIL

By **DON KLIEWER,** World Oil Staff

AFRICA: Two oil pays reported in the new field found in French Equatorial Africa by Societes Petroles d'Afrique Equatoriale Francaise, gaged at 37,125 and 171 barrels per hour, respectively.

ALGERIA: An oil discovery at 10,400 feet has been reported 63 miles southwest of Ouargla in Central Algeria, in the Grand Erg Oriental.

ARGENTINA: Argentina has requested bids to import 12.6 million barrels of oil as its supply-demand gap continues to widen.

AUSTRALIA: Australasian Petroleum Proprietary Limited announced that Kuru 2 had been spudded in Papua (New Guinea) and had reached a depth of 566 feet. Casing has been cemented at 563 feet . . . Kuru 2 is near to and a replacement for Kuru 1, which was sealed with cement after a gas blow out at 998 feet.

BAHAMAS: The Petroleum Board issued oil exploration licenses to Bahama National Oil Company covering more than 5 million acres on Eastern Great Bahama Bank, Exuma Cays, and Little Bahama Bank in the Bahama Islands.

CANADA: Lowlands Exploration Company, subsidiary of Imperial Oil, is drilling its first wildcat test in the St. Lawrence lowlands with cable tools, located one and one half miles southeast of Leclercville on the south side of the St. Lawrence River. Projected depth is 3500 feet. The test follows widespread geological and geophysical operations on 600,000 acres obtained by Government permit about two years ago in the area . . . Alberta crude may be exported from Vancouver to Japan in the near future. Negotiations through the Japanese Import-Export Agency have been reported to this effect . . . Crude production in Alberta has been subject to cutbacks due to lack of markets; at the same time, reserves have increased and exploration has continued active . . . There were 113 geophysical crews reported operating in the four Western Canadian provinces and Northwest territories at the end of August.

COLOMBIA: International Petroleum Company was reported considering construction of an oil pipe line to be built in extreme southwestern Colombia between Pasto and the Pacific port of Tumaco, a distance of about 180 miles.

An Iranian oil worker washes his hands in an oil pool formed by the discovery well reportedly brought in near Qum, Iran, August 27 in what apparently is the discovery of a new oil field south of Teheran. The well, with oil flowing over the crown block, may be seen in the background. Exploratory drilling in the area is being conducted by Iranians, with help of Swiss and U. S. technicians.

—Wide World Photo.

INDONESIA: Progress was reported in the negotiations between Royal Dutch Shell and the Indonesian Government toward renewal of operations in the North Sumatra concessions operated by Shell before World War II but never returned by the government since the end of the war. Netherlands Indonesian Petroleum (NIAM), a company owned jointly by Royal Dutch and the Indonesian government, would, according to the reported agreement in principle, maintain its head office in Indonesia and be managed separately from the Royal Dutch Shell group.

IRAN: The Iranian Government has consummated plans and begun preparations for the new Iranian Technological Institute at Teheran. Aid is being provided by the United Nations through UNESCO. The new institute will train teachers for technical schools and technicians for industry, including the oil industry . . . Iran's oil industry will need 40 mechanical and electrical engineers annually. Total cost of establishing the institute is estimated at $1.2 million.

KUWAIT: The Sheikh of Kuwait has sponsored the formation of a Kuwait tanker company with a capital of $10.4 million, with the cooperation of Kuwait Oil Company Ltd. . . . Kuwait Oil's Raudhatain 2, located 1.8 miles southeast of last year's major discovery near the Iraq border, reached total depth of 9695 feet. The discovery well, Raudhatain 1, bottomed at 10,301 feet. A smaller rig was to be brought onto the confirmation test to complete the well. The exploratory rig has been moved eight miles east-southeast of Raudhatain 2 and was drilling ahead at 1700 feet on another wildcat . . . Another current Kuwait exploratory test was being drilled six miles northwest of the Bahrah 1 dry hole drilled in 1936 near Kuwait Bay.

LEBANON: A. S. Onassis, the Greek shipowner, has concluded a tentative agreement whereby he may invest $1.4 million in Compagnie Libanese des Petroles for oil exploration in Lebanon. Onassis has employed a surface geologist who reported oil possibilities in the country as "not unfavorable," though expressing preference for the southern portion. Concession terms were yet to be resolved.

PAPUA: Associated Freney Oilfields has joined with Papuan Apinaipi Petroleum Company to undertake exploration in Papua. Freney will trade a drilling rig, now in Western Australia, for Papuan Apinaipi stock.

PERU: Amotape Oil Company has completed two wells—with good but otherwise not evaluated results—on its 171,000-acre lease in the northwest part of the country, adjoining the property of International Petroleum Company, Compania Petrolera Lobitos.

TRINIDAD: Negotiations through which Colorado Oil and Gas Corporation of Denver proposes to purchase Trinidad Petroleum Development Company had reached the stage

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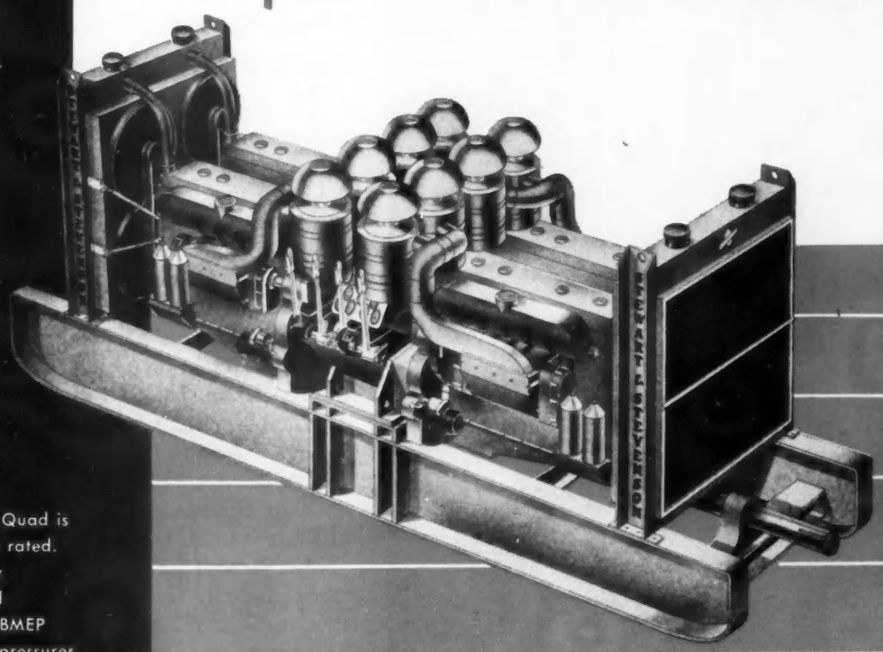

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Several years ago, Stewart & Stevenson introduced the Series 6-71 Quad to the oil industry. No other engine unit has ever matched it for service. Now, here is a new, higher horsepower 6-110 Quad with the same characteristics for dependability and performance of the earlier model, *yet with 55% more horsepower.*

The new GM 6-110 Quad by Stewart & Stevenson utilizes approximately 98% standard GM Diesel Engine parts in both the gear and engine applications. It uses tandem twin gear parts in a newly designed and ruggedly built case of welded steel construction, designed especially for the 6-110 Quad application.

The New 6-110 Quad is very compact, and, in most instances, will fit into the same space as the earlier Quad 6-71. This new 6-110 Quad has the lowest unit cost of any diesel engine power arrangement with comparable horsepower.

Please write, phone or call your nearest Stewart & Stevenson Representative or Branch for complete details.

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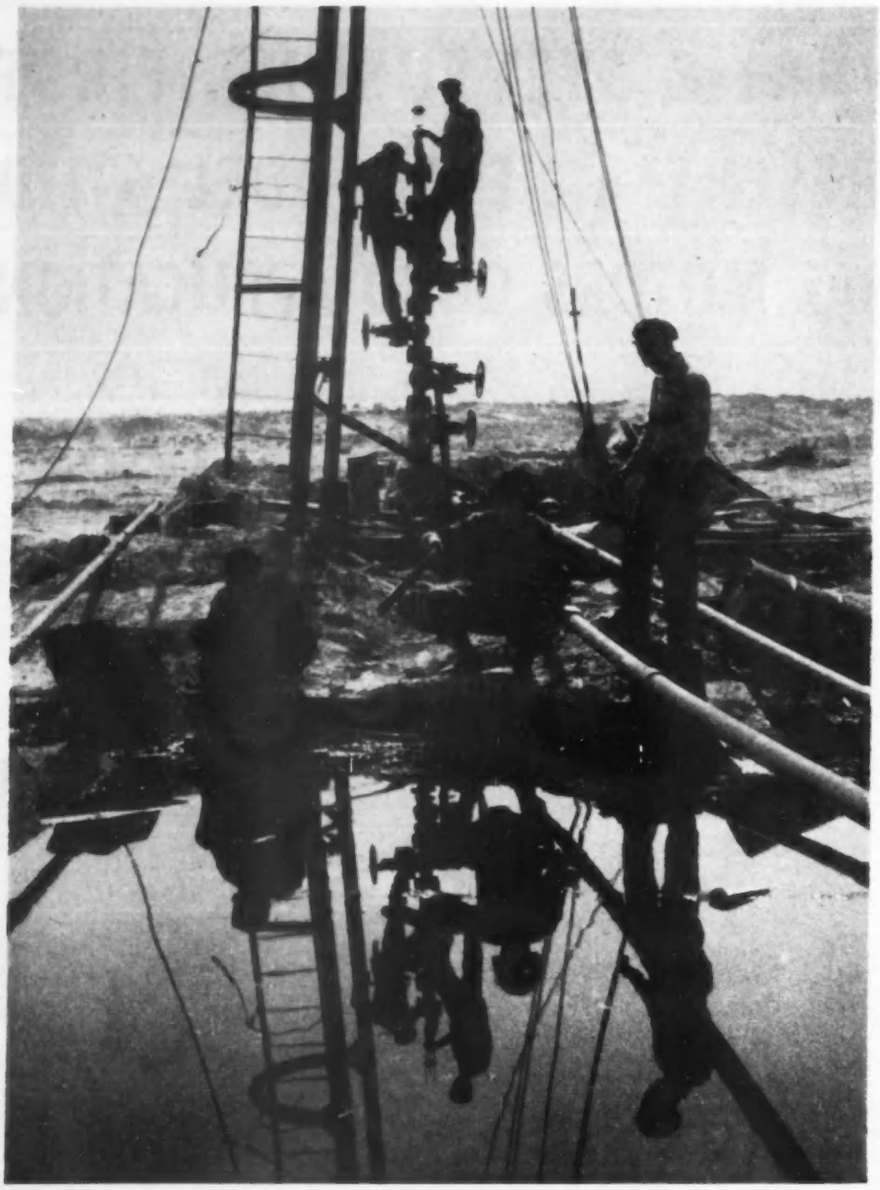
Hydraulic actuated disconnect clutches. Power may be taken off either end of the 6-110 Quad. A dual power takeoff arrangement is also available.

Reduced fuel consumption. The New 6-110 Quad delivers more horsepower per fuel dollar than previous units.

The 6-110 Quad is conservatively rated. It is naturally aspirated and consequently BMEP and cylinder pressures are low.

Standard General Motors Diesel Parts in both the gear and engine applications.

Adapted, developed and guaranteed by Stewart & Stevenson, The Nation's Largest Distributor of Diesel Engines.



Twenty test wells reportedly have produced oil in the Karamai oil district in Sinkiang, China's richest major oil discovery and site of this producer. In addition, a big structure has been discovered at Uerho, 62 miles northeast of Karamai, by a seismological team. Data obtained so far suggests that it is very likely connected with Karamai to form an extensive oil area. A drilling rig reportedly has been built at Uerho. A new city is springing up in Karamai in line with the large scale oil prospecting in this oil area. It will include workers' housing, hospital, a workers' palace of culture, skating rink, open air theater, schools and churches. Photo by Eastfoto.

where both firms felt the transaction should be discussed with governments of both Great Britain and Trinidad.

TURKEY: Turkiye Petrolleri Anonom Ortakligu (51 percent owned by Turkish government) reported encouraging results from recent drilling in the Garzan area of southeastern Turkey. Seven more locations were staked to evaluate the apparent oil discovery.

UNITED KINGDOM: Oil companies placed orders for $209.16 million worth of materials and equipment in the United Kingdom during the first six months of 1956, an 18 percent rise over the same period last year . . . The British Petroleum Company is considering construction of a crude oil tanker terminal located at Popton Point on the south shore of Milford Haven in South Wales to be connected by pipe line to BP's 60,000 barrels per day Llandarcy refinery. Two supertanker berths, capable of handling ships of any size now planned, and other facilities would be built. The crude line would be 16- or 18-inch and would have a daily capacity of 100,000 barrels. Total cost of the scheduled three year project is $14 million . . . Oil consumption in the United Kingdom reached 12.6 million tons, a new record, during the first eight months of 1956. Industrial plants continue to switch from coal to oil, and British industry is now using twice as much oil as in 1952. By 1960, a 100 percent increase in oil consumption over that of today was envisioned.

VENEZUELA: Venezuela Syndicate, a U. S. independent oil company, has increased its oil output and entered the exploration field by buying Talon Petroleum, C. A. Control of Venezuela Syndicate is held by Clint W. Murchison, Cecil V. Hagen and Roy B. Kelly . . . Creole Petroleum Corporation has signed a $17 million contract for a marine terminal in Lake Maracaibo for tanker loading.

Libya Grants More Oil Exploration Concessions

The Libyan government has announced the following oil exploration concessions in recent months:

California Asiatic Oil Company, subsidiary of Standard Oil Company of California, and Texaco Overseas Petroleum Company, subsidiary of The Texas Company, each received an undivided one-half interest in 14.2 million acres in Cyrenaica and Tripolitania. Extensive geological and geophysical work is planned.

Seven concessions totaling about 18.8 million acres have been granted to Esso Standard (Libya), Inc., an affiliate of Standard Oil Company (New Jersey). Four are in Tripolitania, two in Cyrenaica, and one in Fezzan. Preliminary geological work has been done, and extensive surface geological and geophysical work is planned for the near future.

Compagnie Francaise des Petroles, the largest French oil company and a member of the Iranian Consortium, received two concessions, one in Tripolitania of 3.6 million acres, and the other along the Gulf of Syrtes with a 1.5 million-acre area.

The Libya Branch of Mobil Oil Company of Canada Ltd. has an 11.5 million-acre grant. Anglo-Saxon Petroleum Company, Ltd., has concessions totaling 12,821 square miles, including three grants in Tripolitania, and one in Cyrenaica. Libyan-American Oil Company, affiliated with Texas Gulf Producing Company, has the largest grant to date, totaling 40,000 square miles. Ohio Oil Company, Continental Oil Company, Amerada Petroleum Company, and Bunker Hunt Company also are reported to have received concessions.

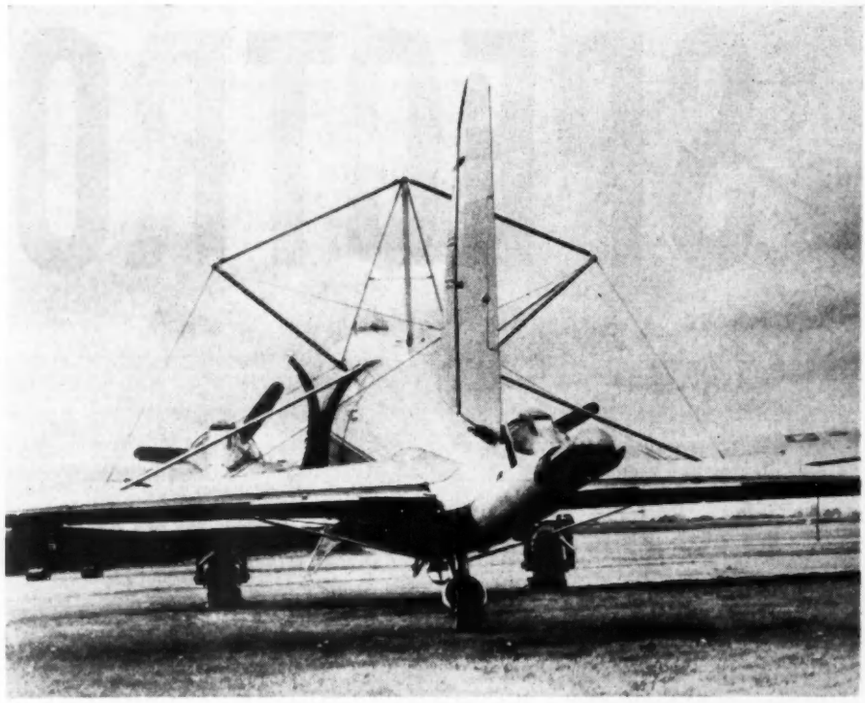
Gulf Bolivian Subsidiary Will Conduct Exploration

Gulf Oil Corporation has formed a subsidiary, Bolivian Gulf Oil Company, to carry out an oil exploration and development program in Bolivia. This move resulted from an agreement between Gulf Oil and the Bolivian government which reportedly will be the basis of a formal contract.

Under the pact, Bolivian Gulf will acquire a permit to explore 3,750,000 acres within the reserves of Yacimientos Petroliferos Fiscales Bolivianos, the government oil agency. Within four years, Bolivian Gulf will be allowed to select 1,225,000 acres in which it would have development rights for 40 years.

Under terms of the agreement, Bolivian Gulf will pay the Bolivian government 11 percent royalty in oil from production, plus 19 percent development tax.

Additionally, Bolivian Gulf will help finance a 200-mile pipe line from Sicasica, Bolivia, to Arica, Chile, the Pacific Coast port. Bolivian Gulf's share of the Sicasica-Arica pipe line financing will be $5 million of the estimated total cost of $10.5 million.



This British "flying laboratory," complete with electronic equipment designed to detect areas of likely mineral deposits, including oil, will conduct surveys for the Spanish government, which is sponsoring geophysical operations.

Mexico Announces Major Increase in Production

A substantial rise in production to 265,000 barrels daily and in reserves amounting to 2885.9 million barrels were announced by Petroleos Mexicanos, government owned oil monopoly, in its annual report to President Ruiz Cortines.

Total production in the period between Sept. 1, 1955, and Aug. 31, 1956, was 91.56 million barrels. Total reserves had a gross increase during the year of 240.9 million barrels and a net increase of 127.7 million barrels, discounting the production of the year.

Other highlights of the report were:

• Drilling—372 wells were completed during the 12-month period of which 81 were exploratory and 291 were drilled in the process of extending and developing existing fields. Total footage drilled amounted to 2,097,278 feet, highest in the history of Mexico's oil industry. Twenty new drilling rigs were bought, bringing the total to 115. Discovery of 21 new gas and oil producing fields was announced.

• New projects completed included:

A gas absorption plant in Reynosa with a capacity of 300 million cubic feet daily.

An additional refinery in Reynosa producing 10,000 barrels daily.

A refinery in Minatitlan with a 50,000 barrel daily capacity and a cracking plant producing 12,000 barrels daily.

A pipe line from the recently discovered Angostura field to the port of Veracruz. This line has a capacity of 20,000 barrels daily.

An oil line from Poza Rica to the refinery of Atzcapotzalco, servicing the capital city, with a capacity of 3000 barrels per day.

A pipe line from Tampico to Monterrey, which was scheduled to go into service in October, will transport 25,000 barrels per day.

• Exploration was carried on principally on the coasts of the Gulf of Mexico, but some activity was reported in the states of Chihuahua, Coahuila, Nuevo León, Yucatan, Campeche, and Baja California.

The 21 new fields discovered during the year were distributed as follows:

Northeastern Zone: gas producers —Guillermo Prieto, Azucar, Culebra and Matamoros; oil producer, Berrendo.

Northern Zone: Macarena, Nuevo Progreso, Chichimantla, Mesa Cerrada, Tamaulipas, Tamatopo, Boca de Lima, Las Cañas, Loma del Pozo, Gutiérrez Zamora, San Andrés, Tecolutla, and Mecatepec Norte, all oil producers.

Southern Zone: Bitzal, Tacuilolapa, and Agata, oil producers.

Reports on exploration in new areas included Baja California's three unproductive wells; Coahuila's well drilled at Peyotes without positive results; Nuevo Leon's Culebra field discovery. In the peninsula of Yucatan, three unproductive wells were drilled. In the state of Chiapas, information gotten from the drilling of Ostuacán 1 led to the drilling of Unión 1, which was in process with promising results.

Exports during the 12-month period from Sept. 1, 1955, to Aug. 31, 1956, amounted to 25,165,000 barrels. Exports were seriously affected by floods in the coastal region last fall.

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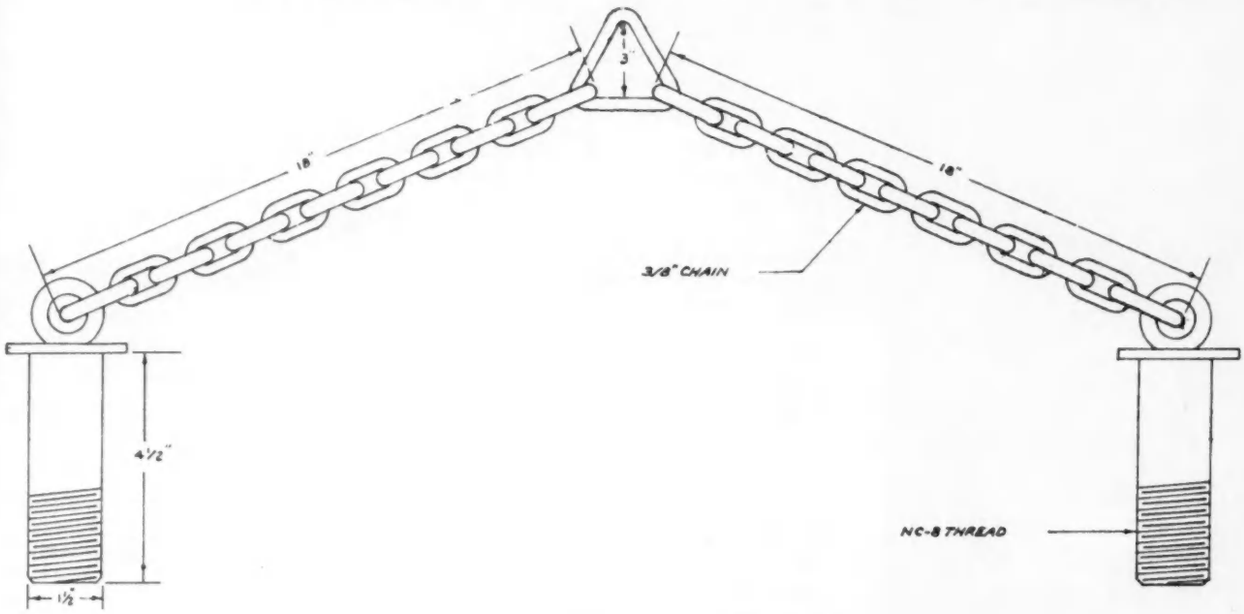
DRILLING HINTS

These **How-To-Do-It** Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.



Improve Hoist for Casing Head Parts

To facilitate handling the casing head housing and spool, construct a bridle arrangement of two 18-inch lengths of 3/8-inch chain and join them with a triangular link. Attach a threaded pin to the opposite ends of the chains. Insert the threaded pins into the bolt holes of the casing head housing or spool and install nuts on the pins. The spool or housing can be handled easily by attaching the cat line to the triangular link.

Previously, the casing head housing and spool were handled manually.

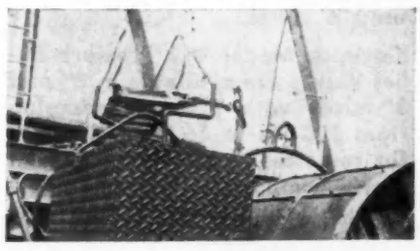
Use of this bridle arrangement not only reduces the time required to nipple up by making it easier to position and land the casing head, housing and spool but is also a safety factor. By not handling the casing head parts manually, the danger of smashing finger, hands or feet is eliminated.

Submitted by an employe of the Humble Oil & Refining Company.

How-To-Do-It Ideas

Earn Money, too!

$10—WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of that latest idea and send it in with a picture or drawing of the installation . . . if accepted, $10 will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.



Handle Shale Shakers With Catline or Gin Pole

In order to facilitate easy handling of shale shakers and chemical mixing tanks, along with other auxiliary equipment, weld bails near the center of the piece of equipment to facilitate handling with catline or gin pole.

As noted in the photograph, one operator has used ¾-inch round stock, or sucker rod material, to form bails on top of his chemical mixing tank on the left, and also on his shale shaker at the right. Mount both of these pieces of equipment inside the return mud tank and lift them out or off of their racks when transporting

Mud Pump Relief Valve Importance Becomes More Critical

As mud pumps are necessarily operated at near capacity to meet the constantly increasing demands on drilling circulating systems, the safety demands on the relief valve become greater.

Responsibility for reducing hazards of personal injury, equipment damage and drilling trouble by relief of excessive drilling mud pressures, calls for a valve that assures positive instantaneous pressure relief at maximum volume and automatic restoration of circulation upon correction of the overloading condition. These requirements have been accomplished in the Kinzbach Model 112 Pressure Relief Valve by combining two unique methods of restraining the valve piston, yielding a characteristic action from a decreasing force against the valve piston on opening movement, and conversely, an increasing force during closure. This assures higher effective lift during valve action.

When excessive circulating pressures occur, the valve either repeats its cycle of rapid opening and closing, or remains open until the obstruction is removed or the pump stopped. Momentary blocks do not require pump shutdown to reset the valve. Movement of fluid may not be materially affected, preventing danger of stuck drill pipe as might occur with arrested circulation. Compounding Heads are available where pumps are used in series.

Kinzbach Model 112 Pressure Relief Valves are available in 2" and 3" sizes with pressures ranging from 500 psi to 16,500 psi. Write for complete data or consult your new Composite Catalog. Sold through Supply Stores everywhere.

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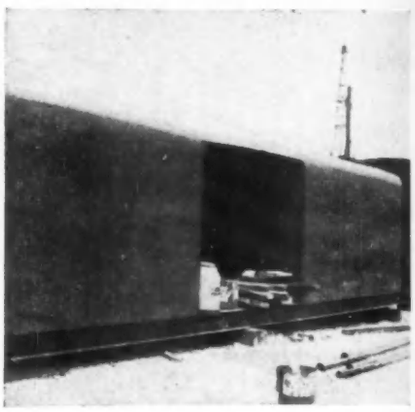
the mud tanks. This bail arrangement also makes it easy in case these pieces of equipment must be removed for maintenance or replacement.

Any field or shop welder can make these braces in a matter of minutes at the shop and can attach them to the piece of equipment the next time he is on location. The use of well-supported bails on equipment not only gives an easy handling device, but prevents the damage of equipment when a wire line is passed around the equipment and would cause damage due to the weight of equipment when lifted.



Mount Two Doghouses On a Single Skid

To save time and effort when moving onto location, and also to cut down on the number of loads, mount the crew changehouse, or crew doghouse, and the spare parts, or tool doghouse, on a single skid. It is also more convenient when moving to have to truck only one skid than if two or more have to be handled.

Build these doghouses with a small intervening space between the two covered by regular roofing metal the same as the doghouses to provide access from either end. This arrangement is more compact, more easily handled, and has a better appearance on the location than two smaller doghouses would, and can afford a savings in both fabrication and transportation.

Build Heater for Warmth And to Dry Clothing

As the weather begins to turn cold, various types of heaters can be seen on Gulf Coast oil wells. The illustrated heater not only provides

PGAC celebrates its 10th ANNIVERSARY!

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and to everyone in the Oil Industry—we say, "THANK YOU"!

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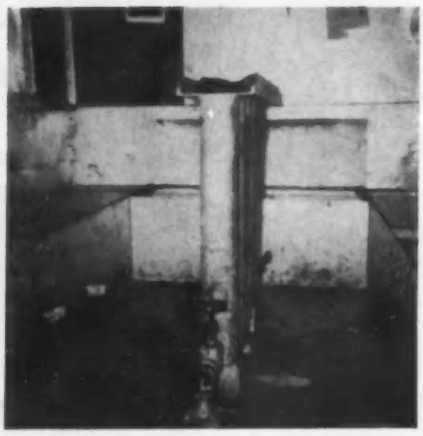
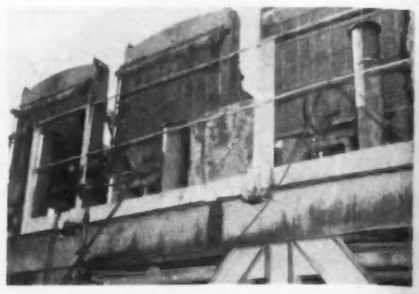


warmth for the workmen while they change clothes, but also gives them a convenient place to dry their wet work gloves.

Construct the heater from six pieces of 6-inch pipe which are mounted in an upright position. Close the top of the pipes by one piece of channel iron welded in place. This forms the glove dryer. The bottom of each pipe is closed. Steam is admitted into the first pipe through the regulator valve. After that it passes into each pipe through a small tube connecting the pipes.



Attach Guard Rails To Save Rigging-up Time

Save rigging-up and tearing-out time through the use of guard rails that need not be removed and carried separately. Attach the rail sections, made of angle iron and sucker rod material, at floor level by means of salvaged rotary chain links. Weld the fixed portion of each hinge unit to the underside of the top flange of the I-beam sub-base. Latched together at the top, merely drop the rail sections at moving time to hang out of the way until needed again at the next location.

Another advantage of the hinged segments is that whenever an engine or other piece of equipment is moved on or off the rig floor, it is necessary to drop only the one or two segments of rail adjacent to that area and without having to disturb the remainder of the railing system.

Insure Rig Safety In Case of Bolt Failure

Place the safety guard on the steam end of the illustrated pump to avoid injury to rig personnel in the event of a bolt failure. Secure a heavy gage steel plate to the skid mount and also to the pump frame.

In the event of a bolt failure the possibility of its injuring someone is slight.

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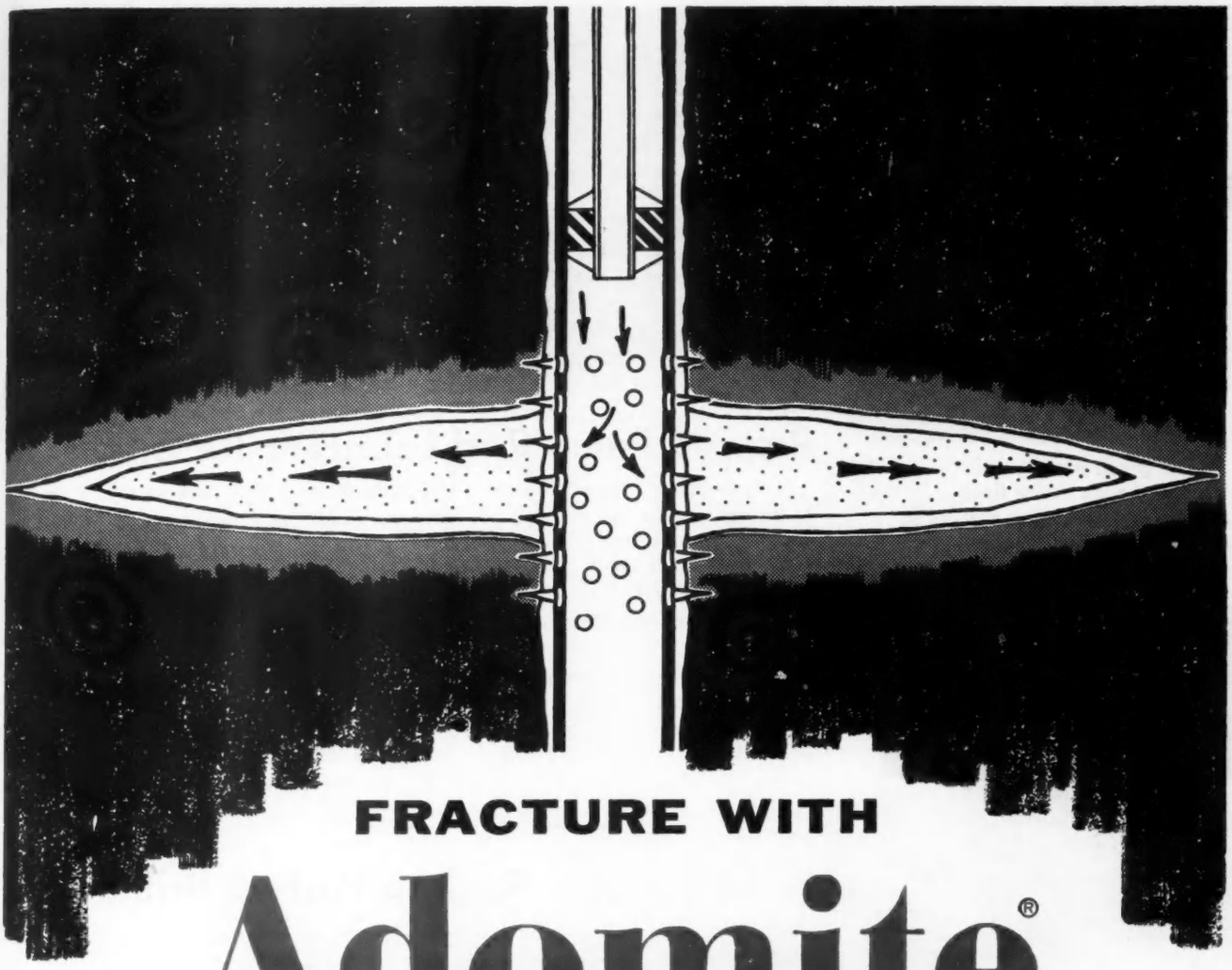

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Lower transportation costs. The fracturing oil costs you nothing when you use your own lease crudes.	Decreased friction losses. The low viscosity of Adomite-treated crudes or gelled crudes permits the use of less pumping equipment than viscous refinery residuals.	Compatibility of fracturing fluid with reservoir oils. Since Adomite is used with lease crudes, the fracturing fluid is fully compatible.	Fluid loss control with one additive. Adomite is all you need to control fluid loss of kerosene, crudes, gelled crudes or refinery residuals.

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Provide Pump Rod Lubricant Reservoir

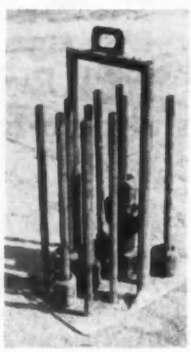
To provide a suitable reservoir and lubricant system for cooling plunger rods on pumps, use an oil reservoir tank that has a series of baffles in it for draining off foreign matter so that it will not be recirculated through the pump.

The return line from the pump housing allows the oil to enter at a high part at the front of the reservoir tank, pass over the small baffle, and under the next baffle. Oil from this third chamber can enter the long reservoir tank where it is picked up again and recirculated onto the rods. The plug at the lower front corner of the first photo is used to drain off water and any sediment that might collect in the tank.

This system is economical, helps keep the oil clean, and prevents wear and tear to the packing glands and plunger rods.

Build Portable Rack to Protect Drill Pipe

To sort, store and handle new and used drill pipe protectors simply build a portable rack similar to the one shown in the photograph. Drop protectors over pins made from evenly spaced lengths of 1¼-inch pipe welded to a rectangular steel plate base. Depending upon the length of pins desired and size of protectors used, carry anywhere from 60 to 80 protectors on the 12-pin rack shown. Provided with a 2-inch pipe bail for easy handling by an A-frame truck, spot the unit in a small area on or adjacent to the rig floor.



Unlike storing them in a large bin, this method of handling protectors minimizes damage from crushing, and, stacked only four to six high, permits rapid inspection and removal of individual protectors. The small expense involved in materials and welder's time easily is offset by the man-hours and rig time saved through handling of protectors with such a rack.

Use Insect Flit Gun For Small Paint Jobs

Where it is necessary to keep machinery along the Gulf Coast continually painted, a quick way to paint on small jobs may be obtained by means of an insect spray gun. Mix the paint the same as for a compressed

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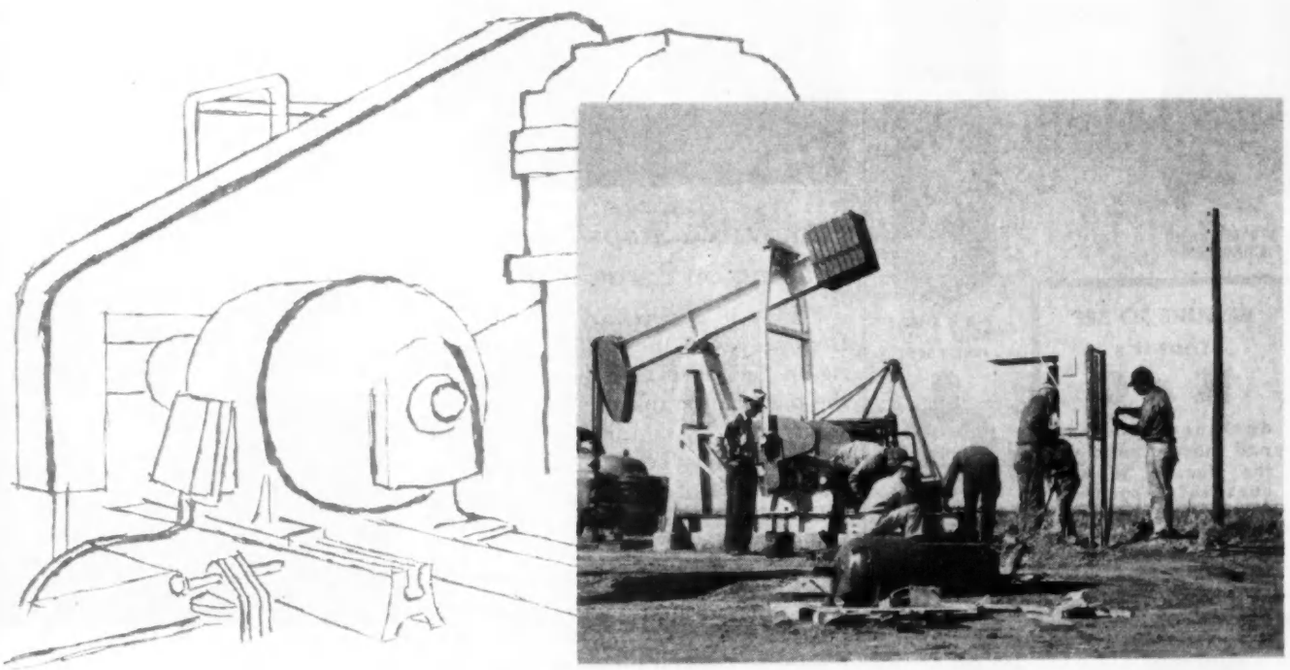
Purchased Electric Power



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DRILLING HINTS . . .

air gun and place it in the container for the insecticide. Screw on the gun and operate the plunger.

On cleaning tanks and equipment, place the solvent in the gun and spray onto the greasy equipment. After it has been allowed to stand some time, spray again and wipe off the remainder with rags. Follow this with light gasoline. Then paint the equipment as shown to give a fine even coat. Near the seashore, two or three light coats give the best results.

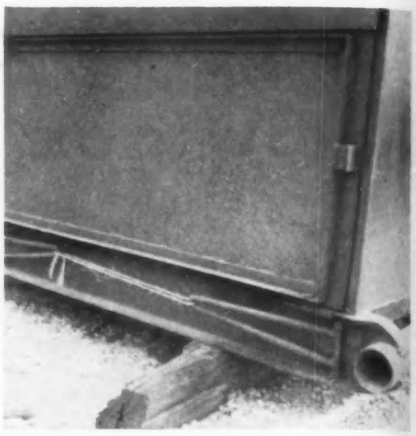
Removable Stops Ease Loading on Barge Rig

Where it is necessary to roll pipe from barges to the drilling platform, rig up the side of the pipe rack so that the pipe can be rolled either way, yet will be entirely safe in case the barge shifts suddenly. To make this possible, weld lengths of 2½-inch pipe to the sides of the pipe stands and place lengths of 2-inch pipe in them.

When the drill pipe is being racked from the rig floor, stick the 2-inch pipes into the 2½-inch wells. When it is necessary to roll the pipe to or from a barge, remove the 2-inch stakes, and the joints will roll smoothly over the ends of the racks.

Support Utility Shed On Folded I-Beam Braces

The light plants, and in some cases the air compressors, around the rig are separately skid-mounted and enclosed in small utility sheds. For a new method of getting sufficient room



and ventilation around these sheds, skid-mount the plant on I-beam braces with half of each side folded down to form the flooring. Weld triangular braces into the I-beam recess that will swing into the I-beam recesses when the unit is being moved. Tie the braces, one at each end, to each other by a short piece of soft rope to hold it out of the way while moving.

It is a simple matter when this unit was spotted on location to cut the rope, swing these floor supports out into position and fold the sides down. With this type of arrangement it is not necessary for the operator to worry about leveling or bracing for floor support.

Utilize Sleeping Sign For Weary Pusher

Many a weary toolpusher has been aroused out of a sound sleep by someone inadvertently coming into the pusher's cabin or trailer.

To avoid this sort of thing, a pusher working in the Gulf Coast area neatly painted a sign containing the appropriate word "sleeping" and now hangs it outside his door when taking a well earned snooze.

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DME

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DMS, the primary flocculant-defoamant, and **DME**, the emulsifier, are new chemicals specifically developed for use in the make-up of Surfactant Muds. Ample stocks, technical data and engineering service at the rig are now ready. Consider this recent advance in petroleum technology in planning drilling and completion operations, wherever mud-making shale or high temperatures are expected.

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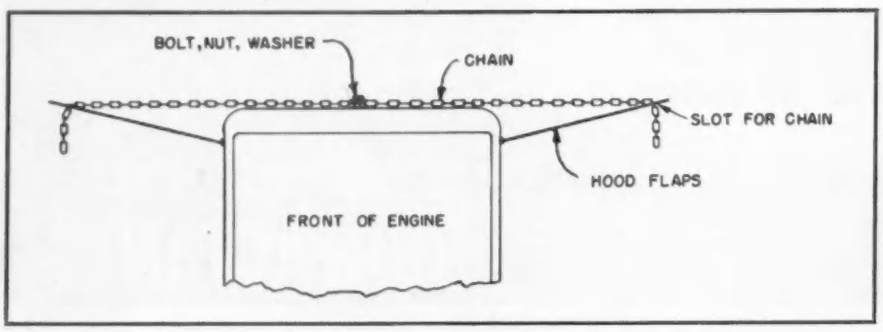
PRODUCTION HINTS

These How-To-Do-It Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.



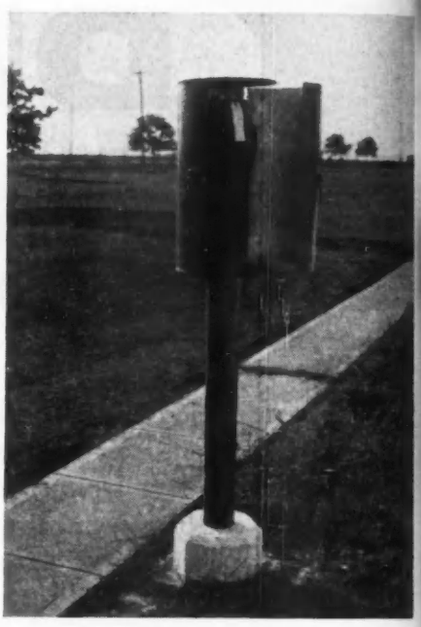
Hold Engine Hood Side Panels With Chains

The illustration demonstrates a safe method of holding engine hood side panels in a raised position while the engine is being serviced.

To duplicate this method, fasten the middle link of an 8-foot chain to the top of the engine hood using a bolt, nut and washer. This allows one-half of the chain to hang on each side of the hood. Cut a slot in the bottom edge of the side panel to accommodate the chain. The side panels are held in a raised position by engaging a chain link in each slot.

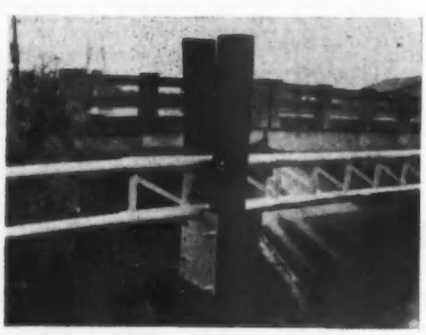
This is a real improvement over the rather hazardous method of propping the panels up with poles, tools or any handy object. Too, the chain is always there since the bolt prevents it being borrowed for some other purpose.

(Submitted by an employe of Humble Oil & Refining Company.)



Fire Extinguisher Holder Made From Old Pipe

Keep your CO_2 fire extinguisher handy by cutting a piece of 12-inch pipe two or three inches longer than your extinguisher. Split the pipe in half lengthwise, placing a set of



Help Small Pipe Lines Jump an Underpass

To extend small diameter pipe lines across a gully or an underpass string the lines over the underpass by using them as the horizontal members of a welded truss. To protect the lines from the effect of welding, slide a slightly larger diameter pipe over the outside of the pipe lines and weld into place as shown. Using the outside shell as the base, weld a series of vertical and diagonal supports into place. This supplies rigidity and reduces the bending moment by turning the pipes into a structural girder.

This entire unit may be prefabricated using pieces of angle iron for supports.

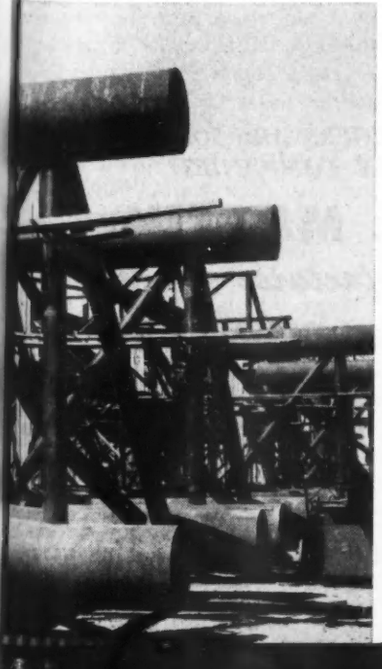
Place creosote poles about a foot apart on each side of the highway to which steel plates are bolted to support the line.

This type installation is comparatively inexpensive and relatively easy to install.

How-To-Do-It Ideas Earn Money, too!

$10—WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of that latest idea and send it in with a picture or drawing of the installation . . . if accepted, $10 will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

Here . . . the wet-dry corrosion zone gets time-proved protection at lower cost



Magnolia Petroleum Company engineers did a lot of careful investigation before they selected the material for the wet-dry corrosion zone in the Company's Central Separator platforms located near Eugene Island, Louisiana. They were well aware of the severe service life threats and so material durability was all-important. But material *economy* was essential, too. In other words, for the particular application where serviceability as well as corrosion protection are essential, they wanted a material that would provide lowest-cost-per-year of service.

They found, after thorough reviews of material cost and performance in salt water services, that wrought iron answered their requirements. Nearly 269 tons of wrought iron pipe and plate were used for dolphin hoods, boat landing supports, bracing for dolphins and pile clusters, and bumper strips for landing docks.

There's no need to practice "trial-and-error" in material selection for offshore services. The hundreds of wrought iron installations still serving in a variety of salt water applications provide documented proof of the material's ability to safeguard against corrosion. We would like to review those records with you. Just write. Your request will be handled promptly.

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ALSO ELECTRIC FURNACE QUALITY STEEL PRODUCTS

Perfect Results with MARTIN PLUNGERS everytime . . .

Like any precision instrument or tool, there is a proper technique for the use of Martin Plungers.

1

Proper Plunger Length

The deeper the well the longer the plunger required. Three rings per 100 ft. for the 1¼" and smaller diameters, and two rings for the larger diameters, is simple rule to follow. Add extra length for stroke-thru.

2

Proper Ring Size

Gravity, Temperature and water content determine the ring size to give free travel with minimum slippage. There is no reason to have a stuck plunger, or too loose a fit. You can have any desired fit by steps of .005".

3

Proper Pre-swelling

Why run Martin Split Rings dry, when pre-swelling will get much better results? Even lube oil or grease will tighten them in the grooves, and when rolled down and tight you are assured of trouble free operation.

Complete, detailed instructions for using Martin Plungers are given simply and quickly in John N. Martin Catalog No. 4. All guess work is eliminated. You obtain proper ring size for a correct working fit, proper plunger length for your particular well, and proper pre-swelling of rings. *It's a fact: — you have perfect results with Martin Plungers everytime — regardless of water or sand conditions — when you follow the simple instructions in John N. Martin Catalog No. 4. Write for it today.*

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JOHN N. MARTIN

Manufacturer

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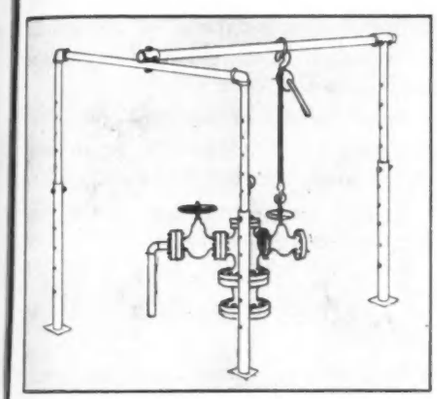
hinges on one side and a simple hasp on the other. Next, cut two steel discs from a piece of flat stock whose outside diameter equals that of the pipe. Weld the discs to one piece of the pipe, as illustrated, allowing the other half to swing freely. By welding this unit to an appropriate length of 4-inch pipe set in concrete, you have fabricated an excellent fire extinguisher holder.

This attractive looking unit will protect the extinguisher from the weather and make it readily accessible when needed.



Inspect Christmas Trees With Portable Frame

This portable frame makes the handling of christmas tree valves and connections on a well a safe task without the expense of a barge or gin pole truck. It is equipped with telescoping legs to regulate the height of the chain hoist and is just as effective on well guard platforms as it is on land.

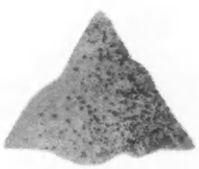
Make the bottom parts of the three telescoping legs of 2½-inch pipe with a ¼-inch base plate eight inches in diameter welded to the bottom. Drill 11/16-inch holes about a foot apart to accommodate the ⅝-inch bolts used to support the extended legs. Make the remainder of the frame of 2-inch pipe and fittings with two exceptions. The diagonal braces are 1-inch diameter pipe and the 6-inch nipples in which the hoist support pipe fits are 2½-inches in diameter.

To provide more flexibility, pivot the pipe supporting the hoist on a ⅝-inch by 7-inch bolt which goes through the nipple and both pipes. The other end of the hoist support goes through a similar nipple welded to the top of the third leg. A bolt is

Valve Trouble?
Cure it with one of these
Harbison-Fischer Balls and Seats

IMPACT / PRESSURE

CORROSION


ABRASION

SHALE / WELL TRASH

Available in all grades except Tungsten Carbide.

MAGNETISM

HARBISON-FISCHER
MANUFACTURING COMPANY—FORT WORTH
"Best Balls and Seats in the Oil Patch"

used to keep the pipe from slipping out of the nipple.

(Submitted by an employe of Humble Oil & Refining Company.)

Diesel Air Horns Warn Of Lubrication Failures

The air horns attached to the mounts of the diesel engine are part of a warning system that has proved successful.

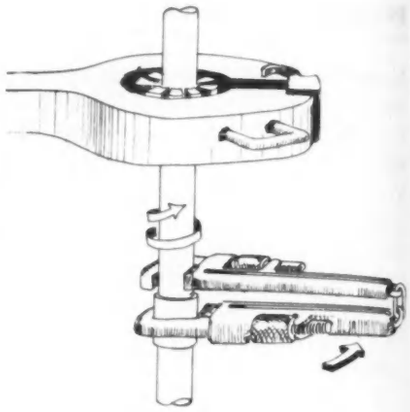
They are attached to the filter of a pressure lubrication system and to a source of compressed air. As long as the lubrication pressure remains where it should, it balances the valve controlling the compressed air inlet at the horns. When the lubrication pressure drops below a predetermined point, the compressed air is released and the horns sound. Regardless of the amount of noise in the vicinity or how preoccupied the operator is, he will be sure to hear the blast from the air horns.

In this manner, an operator is made aware of the serious condition of the lubrication system in time to allow the difficulty to be corrected or the engine stopped.

Aid Tubing Collar Removal With Modified Wrenches

Make two 36-inch pipe wrenches, modified by cutting the handles about 17 inches from the ends and connected with three links of 5/8-inch steel to use in conjunction with air tongs, and save gang time, reduce fatigue and provide safer working conditions in removing tubing collars.

Basically it eliminates the manual



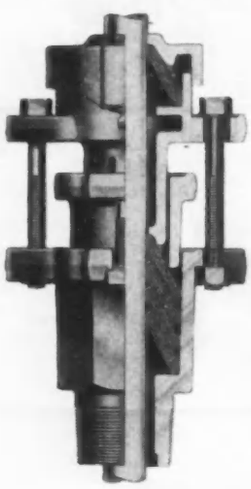
use of the pipe wrench and cheater pipe. It may be used for removing or reversing collars for an entire string, for backups when a string breaks wrong during a trip or for tightening collars when leaks occur after hydrostatic pressure tests.

When used to remove couplings as the tubing is being pulled the following procedure is recommended:

1. Use tongs to make up the top joint of the string.

2. Install the wrenches face to face on the top joint and the couplings as illustrated.

3. Use tongs once again to break out and remove the collar from the

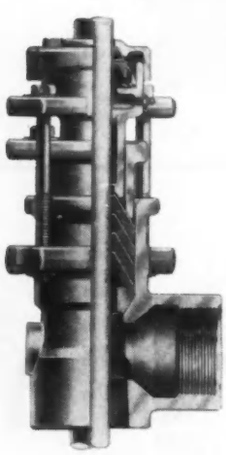


ONE OF THESE
Hercules Stuffing Boxes
CAN END YOUR PUMPING WORRIES*

"REGULAR TYPE" DUPLEX POLISHED ROD STUFFING BOX

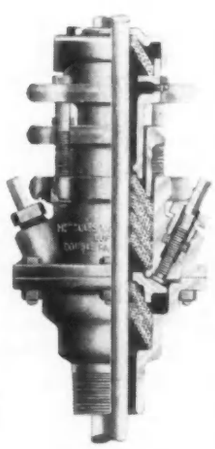
The old reliable, tried and proved on thousands of wells from coast to coast and in foreign fields.

HERCULES OIL RESERVOIR UPPER GLAND



"TEE BASE TYPE" DUPLEX POLISHED ROD STUFFING BOX

A combination Stuffing Box and Pumping Tee. Makes a short connection. Bolt lugs are placed low to eliminate fouling of elevator links. No bell nipple needed as top of body will support elevator. Full opening — unnecessary to remove body when pulling or running rods.



"TYPE DP" DUPLEX POLISHED ROD STUFFING BOX

A Double Packed Stuffing Box for use on high pressure wells and those that flow intermittently. Especially desirable for wells located near buildings, fire hazards of growing crops. Two compression bolts, in bottom sections, are tightened on Cone Rings to pack-off while replacing packing in upper section.

All HERCULES Stuffing Boxes are made of high grade malleable iron which prevents shattering if rods drop. They are tested to 3,000 pounds psi pressure and all use the famous HERCULES Split Cone Packing Rings.

* All HERCULES Stuffing Boxes may be equipped with Oil Reservoir Upper Glands on "problem" wells which pump-off and burn the packing. The polished rod moves through the oil in the reservoir which lubricates and cools it.

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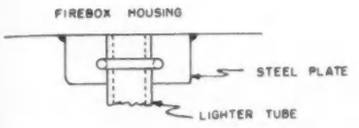
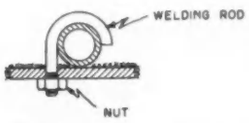
"MANUFACTURERS OF OIL FIELD EQUIPMENT" SINCE 1924
GENERAL OFFICES AND PLANT TULSA, OKLAHOMA
Export Representative: Oil Field Equipment Co., Inc., 30 Church Street, New York 7, N. Y.

bottom joint of tubing in the tubing spiders.

4. Remove the modified wrenches and screw the coupling off the top joint by hand.

(Submitted by an employe of Humble Oil & Refining Company.)





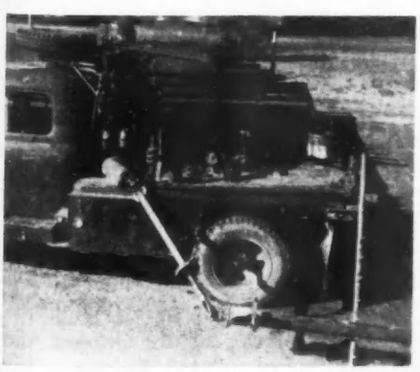
Better Light Installation Promotes Firebox Safety

Failure of the pilot light in a treater firebox can be the result of a dirty lighter and cause a hazardous condition created by an accumulation of gas in the firebox. Removal of the lighter for cleaning is often made difficult by the fact that the lighter is welded in place.

To eliminate this situation and promote safer conditions by allowing frequent removal of the lighter for cleaning, the illustrated installation was made.

To accomplish this, a small steel plate is welded to the fire box as illustrated. A J-bolt, made of welding rod, attaches the lighter to the plate. Such an installation not only holds the lighter firmly in place but also permits easy removal when necessary.

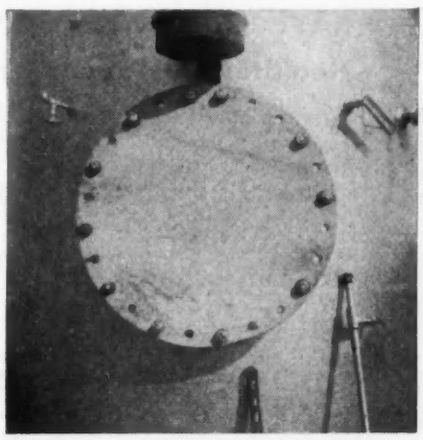
(Submitted by an employe of Humble Oil & Refining Company.)



Make Up Pipe Quickly With Mechanical Device

Reduce the gang time required to lay or break out pipe lines with the illustrated device. Its use is particularly advantageous in handling 2-inch doped and wrapped flow lines and 4-inch water and gas lines. In addition to being faster it requires much less physical effort on the part of the men.

The device uses the power takeoff of a gang truck to make up or break out screwed pipe.



Cover Firebox Opening With Round Wooden Plug

Cover the fire box opening with a round, wooden blanking plug de-

A JENSEN . . .
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MAKE
MORE MONEY!
On-the-spot production records prove that a JENSEN JACK can make your well more profitable.
Get the proof first hand. No matter what type equipment you are now using, no matter where your well is located, check your present production records with records established by a JENSEN JACK under the same conditions. See for yourself how much more profitable a JENSEN is—with less servicing and less down time.
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Healdton, Oklahoma, reports:

76 Hours Billed Per Week

$1.18 Per Day Fuel Cost

No Repairs

Ray Clour's Wichtex C-65 is shown on 5780-foot tubing job on major-company lease near Healdton, Oklahoma. The C-65 works to 6500 feet; other Wichtex Models range from 1500 to 15,000-foot capacity.

. . . with this

WICHTEX

Well Servicing Unit

Ray Clour writes: "We are glad to explain why we use Wichtex Units. These units are easier to rig up and tear down, they are easier to keep clean, they have an abundance of power, they are an understandable unit, and, above all, they are economical to operate. This unit has averaged 76 hours per week since it was purchased in February of this year. We have had no repair expense, and the cost of fuel has averaged $1.18 per day; we are using butane. Equally important is the consideration the Wichtex people give you when purchasing a unit and thereafter; when you need them they're right there. When we need another unit, it will be a Wichtex."

WICHTEX MACHINERY COMPANY INC.

Burkburnett Road — Wichita Falls, Texas

PRODUCTION HINTS . . .

signed to fit the fire box opening flange while the treater is being steam cleaned. Cover the inside surface of the wooden plate with gasket material to protect it from the steam and water.

This idea is limited to cases where a treater is cleaned with an outside source of steam, because the firebox is not in operation.

Previously the fire box was used to cover the opening. This suggestion, however, is a much quicker means of accomplishing the job.

(Submitted by an employe of Humble Oil & Refining Company.)

Weld Flare Container To Front Truck Bumper

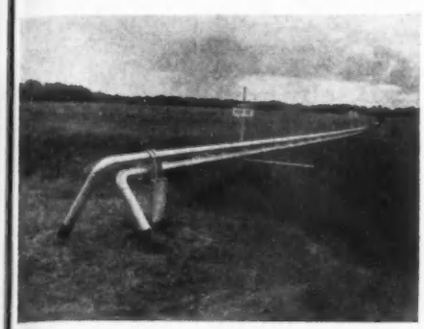
A great many oil field transport trucks carry flares as part of their standard equipment. Too often these flares are misplaced or used and not replaced by someone other than the driver. One truck driver corrects this situation with a flare container which he had welded to the front bumper of his truck as shown.

Make the top and bottom of the container of steel plate. The body is a section of 8-inch pipe. When the hinge and hasp, at the top of the container, are welded in place, the unit is ready for installation on the truck bumper.

As long as there are flares inside, keep the container locked. When the last flare is used, place the lock inside the container, leaving the container

unlocked as a reminder to replace the flares.

Keep the key to the container lock on the ignition key ring so that the driver always knows where the emergency flares are and when they need replacing.



Help Pipe Lines Support Themselves

To run two small diameter lines across a gully a distance of 40 or 50 feet, use the scheme illustrated above. Pour a cement block on each side of the gully with a bracket bolted to the top of it. The brackets, which are made of quarter-inch steel plate, contained a saddle for positioning both the upper and lower lines. Weld stiffeners about a foot long of quarter-inch steel plate at 3-foot intervals between the two lines. In this manner, they are made to support each other with the bending moment kept to a minimum by the comparative light weight stiffeners.

Add the guard rail to keep anyone from using the lines as a bridge. Weld a length of 1-inch pipe about 12 feet long horizontally to the underside of the lower line. Weld a 5-foot piece vertically to the top line. String wire from these members as shown in the photograph.

This system provides a quick, inexpensive and effective means of overcoming the problem presented by the gullies.

Stop Manual Tank Bleeding Without Using Gun Barrel

To continuously drain salt water from stock tanks without installing a gun barrel, install an automatic water bleeder consisting of two risers in the tank bleeder line which are connected as illustrated by a carry-over line. The height of the connection will permit the combined head of oil and water in the stock tank to reach a maximum height of 15½ feet. Above this level the salt water in the bleeder line will flow through the carry-over to the pit. When the tank level has dropped below the height of the carry-over, the flow of water stops.

During normal operation the valve between the two risers remains closed. When the need arises to drain the

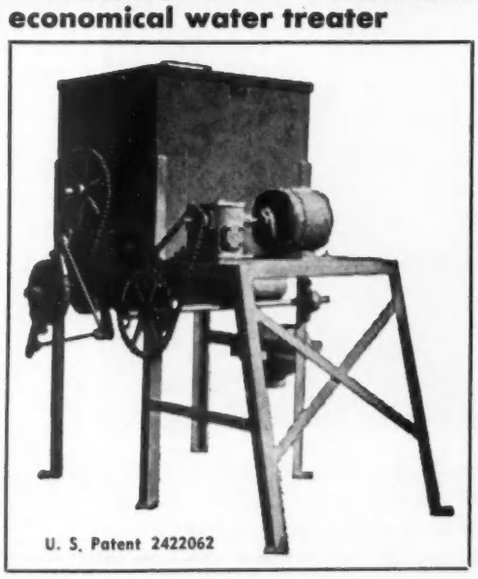
THE WESTERN CHEMICAL FEEDER
the dependable, economical water treater

CHECK THESE FEATURES:

- Used in Oil Well Water Flooding, Municipal Water Treating Plants, Canneries, etc.
- Can be driven by water entering plant for treatment.
- Maintains pre-set water-chemical ratio through a wide rate-of-flow range.
- Adjustable two ways, to feed from a few pounds to several hundred pounds of chemicals per day.
- Also can be equipped with electric motor, or gas engine drive.
- Made to your specifications in various sizes.
- In use the world over.

Whatever your water treating problems may be, investigate the Western Feeder. Write for literature and prices.

For complete description see Page 2777 of the Composite Catalog.



U. S. Patent 2422062

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...and low cost, too!

1. BEST QUALITY! The highest standards of quality and performance—backed by 50 years of experience—go into the manufacture of every *Darcova* valve cup, seating cup and ring.

2. PERFECT FIT! Consistent uniformity and precision manufacture to fit every size and make pump, assure *Darcovas* to be tops in efficiency of operation.

3. RIGHT TEXTURE! Varying conditions of depth, pressure, temperature, fluids and abrasion are not problems when *Darcovas* are used!

Best quality, perfect fit and right composition texture add up to longer, more efficient service...and LOWEST COST!

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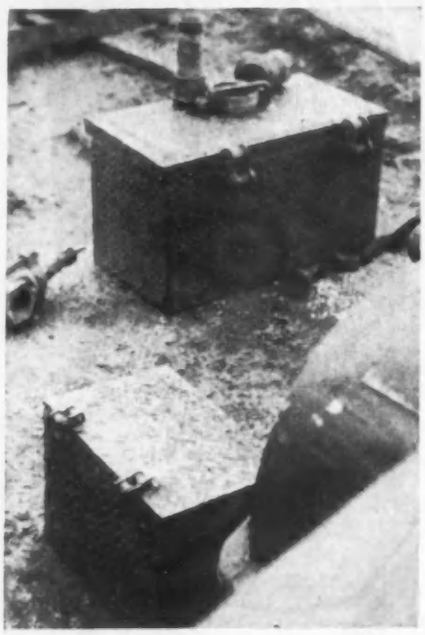
DARLING VALVE & MANUFACTURING COMPANY
DARCOVA ®
THE ORIGINAL COMPOSITION CUP
WILLIAMSPORT 28, PA.

tank this valve may be opened, providing a direct drain to the pit.

(Submitted by an employe of Humble Oil & Refining Company.)



Make Set of Hinges From Chain Link

Provide a set of hinges for a tool box or the door of a dog house by cutting two or three links from an old piece of chain similar to that used in chain tong. Weld these to the box or door as shown in the illustration and the job is complete.

In this photo two different size chain links are used. As the jobs get bigger, use a larger size link to have a good-looking smooth working hinge.

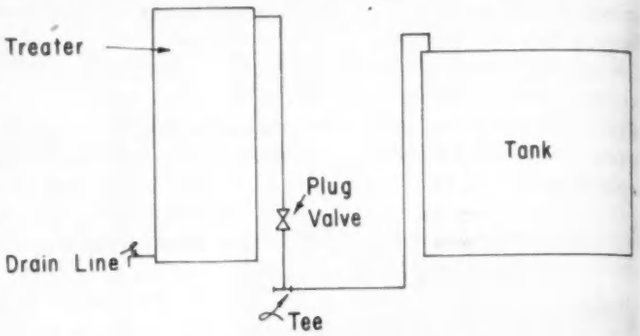
Carry Choke Beans In Shopmade Box

Construct a small wooden box 8 inches by 6 inches by 12 inches equipped with two trays each holding 35 choke beans. Use of such a special container proves convenient in finding the desired size choke bean, in providing a clean storage space and in preventing damage to the choke bean threads.

This simple, inexpensive unit can be put to good use by many pumpers in field operations.

(Submitted by an employe of Humble Oil & Refining Company.)

Improve Means of Draining Flow Treater



The use of this method of draining a flow treater requires slight modification of the oil discharge line from the treater to the stock tank. Use of the suggestion eliminates the need for digging and refilling a drain pit and saves the oil normally drained into the pit by pumping it into the stock tank.

Install a tee at the bottom of the treater riser and a plug valve above the tee as illustrated. To drain the treater, connect a pump to the treater drain line with the discharge connected to the tee. With the plug valve closed, the fluid in the treater is routed through the discharge line to the stock tank. Several advantages of such a procedure are evident, but the primary one is the saving of oil.

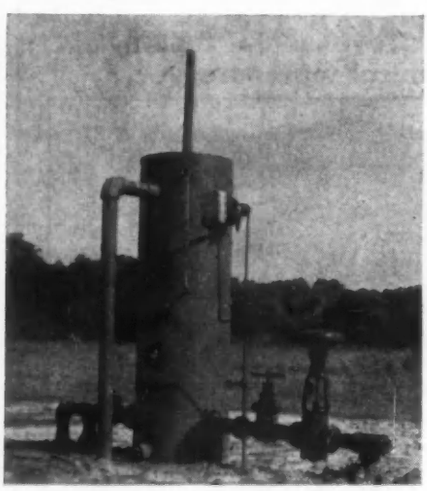
During normal operation the pump is disconnected, the open side of the tee is blocked with a bull plug and the plug valve is open.

(Submitted by an employe of Humble Oil & Refining Company.)

Make Disposal Traps With Welded Plates

Make this salt water disposal trap by welding plates on each end of an 8-foot section of 32-inch pipe. Use the resulting eight barrel tank to replace corroded tanks being used as settling tanks and dumping traps for salt water disposal systems.

When the daily salt water disposal



rates do not exceed 1000 barrels a small cylindrical container such as described above provides satisfactory facilities. A considerable saving resulted from the use of this smaller tank in preference to the large one and the neat compact hookup allows fast movement of salt water from the flow treater to the injection well.

(Submitted by an employe of Humble Oil & Refining Company.)

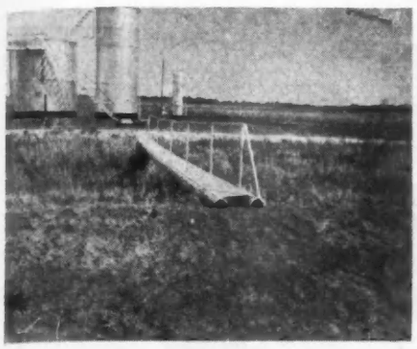
Separator Relief Valve Tested from Ground

Time and safety records both benefit when the pressure relief valve on a separator can be tested from the ground instead of from the top of the separator. If the type of relief valve actuated by raising the handle is used on an installation, it can be modified, as illustrated, to do just that.

To modify the valve first remove the handle. Drill a new bolt hole one inch from the hole previously used to accommodate the pivot bolt. Replace the handle in an inverted position putting the bolt through the new hole.

Now the valve is operated by pulling the handle down. Attaching a wire or small chain to the handle allows the valve to be tested from the ground, making trips to the top of the separator unnecessary.

(Submitted by an employe of Humble Oil & Refining Company.)

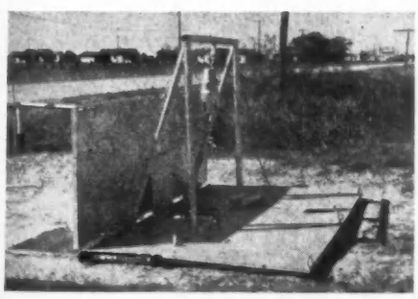


Build a Simple Bridge For Rainy Weather

Two joints of old casing, some used one-inch pipe and a few feet of ⅛-inch sheet steel went into the construction of this small bridge.

Weld the structure together on the spot. It makes a very neat appearance. During the wet weather, which occasionally occurs in the Southwest, it helps make the tank battery in the background more accessible.

Just be sure that the casing is long enough and the railing high enough to be of help, putting the railing on only one side is sufficient to steady the average person, and, with a good welding job, all will be secure.



Make Wellhead Cover Of Sheet Steel, Old Pipe

When it is necessary for a wellhead to be kept below the surface of the ground as shown here, keep the wellhead fairly accessible by making a cover of sheet steel, old pipe, angle iron and half-inch rod. The doors on each side have handles welded at the corners and are counterbalanced to help in raising them. In the center, above the tubing pressure gage, is a small two-foot square trap door to allow quick inspection.

Make the hinges in the unit of sheet steel and rod making the counterweight pulley the only purchased item required. These covers can be made to fit any size cellar without much expense.

TYPE C
"SLIM JIM" — 3 1/16" O. D. x 2" I. D.
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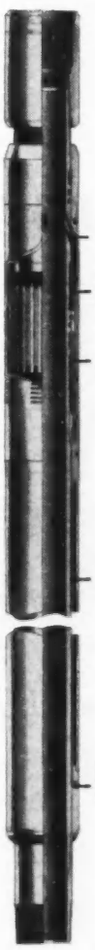

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- ✓ In parallel-string installations, valve can be rotated with both strings in place
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What's Happening

AMONG MEN IN THE INDUSTRY

E. G. Lindroth

Eric G. Lindroth has been named director and senior vice president of **Esso Export Corporation** and appointed to the Esso Export executive committee. He has been with Standard Oil Company of New Jersey and affiliated firms since 1932, and has been a director and treasurer of Esso Export since 1948.

•

Seymour J. Dexter, formerly vice president and secretary of Johnson Oil Refining Company, has been named controller of **Husky Oil Company.** He was associated with Johnson Oil for 24 years, serving as secretary and vice president. Prior to going with Johnson, Dexter was manager of the Statistical department of Paul H. Davis & Co., Chicago.

•

J. W. Mason has been appointed district geologist at **Stanolind Oil and Gas Company's** Wichita, Kansas, District Exploration office. He has been area geologist in the company's district office in Midland since February, 1955. In his new assignment, Mason will direct Stanolind geological activities in the Kansas, Missouri, eastern Nebraska, southeastern Colorado, and the Oklahoma panhandle areas. Employed as a junior geologist in the Albuquerque, N. M., district office in 1950, Mason has advanced through successive positions prior to assuming his duties in Midland.

•

Continental Oil Company appointed four men to new positions in its Development and Research department in Ponca City, Okla. **Dr. Warren L. Jensen,** formerly director of the Central Research division, was promoted to director of the Development and Research department's newly created Petroleum Products division. **D'Arcy A. Shock,** formerly supervision research chemist, was promoted to director of the Central Research division, succeeding Dr. Jensen. **David B. Burrows,** formerly supervising research engineer, is now director of the department's newly created Technical Services division. **Horace E. Luntz** was appointed technical assistant to the manager of development and research.

•

Harry A. Jackson was appointed president of **American Petrofina, Incorporated.** Jackson came to the company from Tide Water Oil Company where he had been vice president and general manager of its Eastern operations. He has been connected with the petroleum industry for more than 35 years, most of the time having been spent with Tide Water. Jackson had also been president of Seaside Oil Company, a Pacific Coast concern, a vice president and director of Tide Water Tankers, Inc., The Flying-A-Company, Hemisphere Transportation Corp.; and Tide Water—Iran, Limited. He was also a director of Transoceanic Shipping Corporation and is a member of the board of directors of Wilmington Trust Company of Wilmington, Del.

•

Harris H. Allen and **D. C. Gilkison** have opened an oil and gas consulting office at 448 San Jacinto Building in Houston. Allen was formerly with Phillips Petroleum Company and Ada Oil Company, and Gilkison was formerly with Amerada, Phillips Petroleum and D. D. Feldman.

•

The Texas Company announced the election by the board of directors of **Wallace E. Avery** as secretary of the company. He succeeds **Walter G. Elicker** who retired after 38 years with Texaco. Elicker was elected secretary in 1945. Avery has been assistant secretary since January, 1954. He joined Texaco in 1945 as an attorney in the Los Angeles office. In 1951 he was made assistant general manager of the Industrial and Public Relations department, with headquarters in New York.

•

Jerry Covington announced his resignation as general manager of **Dela Oil Company** to open his own practice as a consulting geologist. A temporary office will be maintained in Midland, Texas. He worked six years as geologist for Humble Oil & Refining Company in West Texas and southeast New Mexico. He also handled all the land and geological work for Gustave Ring for over two years.

•

Dr. Carl O. Tonberg has been elected a vice president and director of **The Carter Oil Co.** He was formerly vice president and director of Esso Research and Engineering Co., research subsidiary of Standard Oil Company (New Jersey) at Linden, N. J. He will be in charge of production research activities conducted by Carter on behalf of the producing affiliates of **Standard Oil Company.**

Dr. C. O. Tonberg

•

Dr. Dayton H. Clewell has been named manager of **Socony Mobil Oil Company** laboratories. Until recently **Dallas R. Lamont** has acted as manager of the company's research laboratories. Prior to his new appointment, Dr. Clewell was manager of Magnolia Petroleum Company's field research laboratories at Dallas. He will be in charge of all Socony Mobil research laboratories. They are, in addition to the Dallas research center: the Research and Development laboratory, at Paulsboro, N. J.; and the Technical Service laboratory, at Brooklyn, N. Y. Succeeding Dr. Clewell in the Dallas post is **Dr. C. Ivan Alexander** who has been supervisor of the exploration research division at the Field Research laboratories.

Arthur F. Truex

George W. Chapman

Arthur F. Truex, veteran division manager of Sun Oil Company's Mid-Continent Production division, will retire from active service at the end of 1956. **George W. Chapman,** Land department manager of Sun's Southwest division at Dallas will succeed Truex. When Truex retires, he will have completed over 32 years of service to Sun, all of them in the Mid-Continent division. He joined as a geologist. Chapman's first Sun job was at Tulsa in 1930. Early in 1931, however, he moved to the Southwest division, where he has acquired wide experience.

•

American Maracaibo Company has named **Lynn Walker** as reservoir and evaluations engineer in the New York office. He previously was with Creole Petroleum Corporation for six years.

•

T. W. (Tommy) Ward, formerly vice president of Schafer Drilling, has formed a new drilling company with operations scheduled for the Mid-Continent area. The new firm, known as **Tommy Ward Drilling Company,** began operations August 1 with Ward as president. He is a veteran of 25 years experience in drilling operations. He has worked actively in every phase of the oil business and has supervised multi-rig rotary for more than 13 years. Ward, who resigned from Schafer after four years as vice president, announced that **John K. Norman,** assistant vice president, has been named to succeed him.

•

John W. Clark, former chief geologist for **Magnolia Petroleum Company,** has been named assistant manager of the Exploration division. He succeeds **Henry C. Cortes,** who was recently elevated to vice president. Clark was employed by Vacuum Oil Company prior to transferring to the Magnolia organization in 1932. After working with various Magnolia geological crews in Oklahoma and East Texas, he was transferred to the general offices in Dallas in 1937. Later, he was made assistant chief geologist, then was advanced to the chief

John W. Clark

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geologist position in 1952. **Philip H. Jennings** will become chief geologist for the company. After joining Magnolia in 1936 he served in various positions within the company's geological group, both in the field and the general offices. In 1952 he was made assistant chief geologist.

•

Maurice B. Parmelee has been elected secretary-treasurer and a member of the board of directors of **Sun Oil Company, Ltd.** Also, **John C. Agnew** was elected assistant secretary-treasurer, and **Frank R. Markley** resigned as a member of the board but will continue as vice president. Parmelee was formerly office manager of the General Sales department of the parent Sun Oil Company. He has been employed by Sun for more than 24 years. He joined Sun as a clerk in 1932.

Maurice B. Parmelee

•

Charles B. Wrightsman, president of **Standard Oil Company of Kansas** from 1932 through 1954, has been elected a trustee of the Metropolitan Museum of Art in New York City.

•

Dr. Raymond Cecil Moore will be awarded the 29th Hayden Memorial Geological Award of the Academy of Natural Sciences of Philadelphia on November 15. Dr. Moore is professor of geology at the University of Kansas and his written many technical articles as well as three textbooks. The $300 award and medal is given every three years for the "best publication, exploration, discovery or research in . . . Geology and paleontology."

•

D. E. Smith has been named district geophysicist at **Stanolind Oil and Gas Company's** Billings, Montana, Exploration district office. He was formerly staff geophysicist for Stanolind at New Orleans, Louisiana.

The Billings district office is headquarters for Stanolind exploration activities in Montana. Smith will be in charge of all geophysical exploration in the district.

•

John E. Orrell has been named chief mechanical engineer for **Shell Oil Company's** Pacific Coast area. He replaces **J. E. Gallagher,** who has been assigned to Shell's head office in New York City. Orrell started his oil industry career in Shell's Tulsa office in 1935 and has held a number of positions in the company's engineering departments. His most recent assignment was at The Hague, Netherlands, and in the company's New York office.

John E. Orrell

J. Earle Gray has been appointed assistant general manager of **Tidewater Oil Company's** western division. In his new assignment with headquarters in Los Angeles, Gray will assist **Thomas L. Wark,** vice president and western divisional general manager, in conducting and coordinating all drilling, refining, marketing and transportation activities of the oil company in the seven western states and Hawaii. Gray replaced **Charles R. Brown** who has recently been transferred to Tulsa, where he is general manager of Tidewater's activities in the mid-continent area. He has served as district and later division production manager for Shell Oil Company in the mid-continent states and recently was consulting petroleum engineer and independent oil operator with offices in Wichita Falls and Olney, Texas. He joined Tidewater in the western divisional headquarters here as assistant to the divisional general manager.

J. Earle Gray

•

William A. Miller has been appointed manager of the Insurance department of **Richfield Oil Corporation.** Miller, who has had extensive experience in the insurance field, was formerly associated with Lane-Wells Company. He succeeds **David W. Larmer,** who recently retired. He had been associated with Richfield and its predecessor companies for the past 34 years.

•

William M. Quackenbush has joined the staff of **Statex Petroleum,** a subsidiary of **State Exploration Company,** Los Angeles, Calif., as geologist and will be located in Amarillo, Texas. He was formerly with Continental Oil Company where he was assistant to the director of a four company offshore group in California. Prior to that he has had broad exploratory experience in other parts of the country including the Gulf Coast.

•

The Carter Oil Company board of directors elected **W. W. Bryan** vice president in charge of marketing, and a member of the board. Bryan, assistant coordinator of marketing for Standard Oil Company (New Jersey) will have his headquarters in Tulsa. He first was employed by the Virginia division of Esso Standard Oil Co. in 1926. During this period, he held various marketing positions of increasing responsibility with Esso. Bryan was northern region marketing manager for Esso when he became assistant coordinator of marketing for the Jersey Company in June, 1956.

•

Union Oil Company of California announced the election of **Frank R. Denton,** vice chairman of the board, Mellon National Bank and Trust Company, Pittsburgh, to the board of directors of Union. Denton will fill the vacancy caused by the recent death of **George M. Wallace,** chairman of the managing committee, Security First-National Bank, Los Angeles.

Charles A. Houston, former district geologist for **Stanolind Oil and Gas Company** at Jackson, Miss., has been appointed to the newly-created post of district exploration superintendent. **A. T. Teague, Jr.,** succeeds him as district geologist.

•

Henry C. Cortes was elected a **Magnolia Petroleum Company** vice president. He will be in charge of coordination of the company's offshore operations, as well as holding his present duties as company director responsible for Magnolia's Field Research Laboratories. He was formerly assistant manager of the Exploration division. **Stuart Mossom,** formerly assistant manager of the Natural Gas department, was named coordinator of all offshore operations and will work under Cortes' direction.

Henry C. Cortes

•

Continental Oil Company's Coordinating and Planning department has named two men to newly created positions. **James W. Bateman** was promoted to director of the new Projects division. He formerly was technical assistant to the manager of manufacturing. **Dan H. Sanders** was appointed director of the department's newly created Progress Reports division. He formerly was controller of Middle States Petroleum Company.

•

James R. Moyer is now district geologist for **Mayfair Minerals, Inc.,** at McAllen, Texas. He was formerly a geologist for Sun Oil Company in San Antonio, Texas. **Joseph J. Lawnick** with **La Gloria Oil & Gas Company,** Corpus Christi, Texas, has recently been promoted from petroleum engineer to assistant chief petroleum engineer. He was district engineer with Shell Oil Company before joining La Gloria three years ago.

•

H. J. Gruy and Associates announced that **Jack W. Williamson** has joined their firm. His previous experience includes five years with Continental Oil Company where he served as production engineer for the Southwest Regional office in Fort Worth and three years as production engineer and assistant production superintendent for Woodson Oil Company.

J. W. Williamson

•

Ernest A. Carrere was elected a member of the board of directors of **The Louisiana Land and Exploration Company.**

The Standard Oil Company (Ohio) announced the appointment of **Louis E. Black, Jr.,** as general manager of the **Canfield Oil Company,** Sohio's subsidiary headquartered in Cleveland, Ohio. Black entered Sohio's employ in June, 1953, as a member of the Transportation department's executive staff. He was appointed assistant to Sohio's executive vice president a year later and has been in Aviation Sales since April of this year. **John J. Adams** assumes the office of president of Canfield in addition to the duties of his position as manager of Sohio's general office and Subsidiary Sales.

Louis E. Black, Jr.

•

Kenneth G. Grandall opened consulting petroleum and natural gas engineering offices in the San Jacinto building, Houston. He will specialize in valuation and management of oil and gas properties. His 13 years past experience included engineering positions with The Texas Company, Phillips Petroleum Company, and five years with a Houston consulting engineering firm.

•

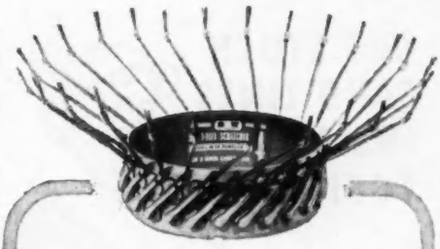
H. P. Arbuckle

P. Superty, Jr.

H. P. Arbuckle and **P. Superty, Jr.,** have been elected assistant comptrollers of **Gulf Oil Corporation.** Arbuckle, formerly manager of accounting functions for Gulf's manufacturing and chemical activities, will be responsible for accounting and related activities of these two operations. Superty, formerly general auditor, will be responsible for accounting matters relating to the company's domestic marketing operations.

•

J. W. Johnson, division geologist, is transferring to staff geologist, northwest division of **Sohio Petroleum Company.** In his new capacity he will study special division exploration problems and projects. **R. A. Bishop,** manager, Regina, is transferring to Billings, Okla., as division geologist, replacing Johnson. **H. G. Sehnert,** district geologist, Midland, is being promoted to manager, Regina, replacing Bishop. **Harold Knetta,** senior geologist, Casper, Wyo., is being promoted to district geologist, Billings district (formerly Lewistown). Knetta is replacing **D. E. Hayes,** who is being transferred to the Oklahoma district as senior geologist.



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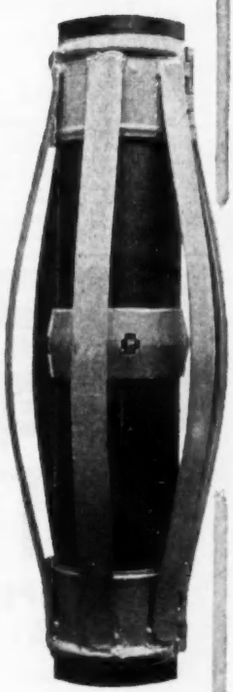

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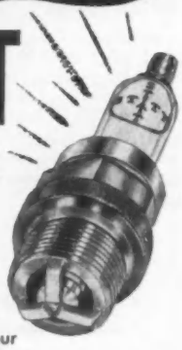

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E. H. Lyon

J. Getgood

E. H. Lyon has been promoted to manager of **Phillips Petroleum Company's** sales department succeeding **E. J. Webster**, who has retired. **John Getgood**, formerly senior assistant sales manager, has succeeded Lyon as general sales manager.

•

R. W. Johnson

Standard Oil Company of California has announced the appointment of **Robert W. Johnson** as assistant comptroller. Johnson joined the company in 1931 as an accountant. He has been traveling auditor for the Comptroller's department, secretary-treasurer for two Standard of California subsidiaries and assistant division comptroller.

•

Stanolind Oil and Gas Company has announced some changes in executive standings. **F. R. Yost**, formerly vice president and division manager at Houston returned to Tulsa as vice president, exploration. Yost will continue as a member of the company's board of directors. **Whitney M. Elias**, formerly general superintendent, producing department, Tulsa, has been elected vice president and division manager at Houston, succeeding Yost. Elias has also been elected to the board. **Charles F. Bedford**, formerly division production superintendent at Fort Worth became general superintendent, producing department, Tulsa, succeeding **Elias. C. L. Larson, Jr.**, division manager and director at Casper, Wyo., has been elected a vice president of the company. **George H. Galloway**, division manager and director at Calgary, Alberta, Canada, has been elected a vice president of the company.

•

H. Thornton Tarvin has been named vice president in charge of operations for the **Delta Marine Drilling Company.** He was associated for 23 years with Loffland Brothers Company. Immediately prior to his association with Delta Marine, he was vice president of the Shoreline Drilling Company with headquarters in New Orleans. In addition to his responsibilities with Delta Marine, Tarvin will assist in the management and operation of Delta Gulf Drilling Company. Delta Gulf is a wholly owned subsidiary of Delta Drilling Company and Delta Marine is controlled by that company.

H. T. Tarvin

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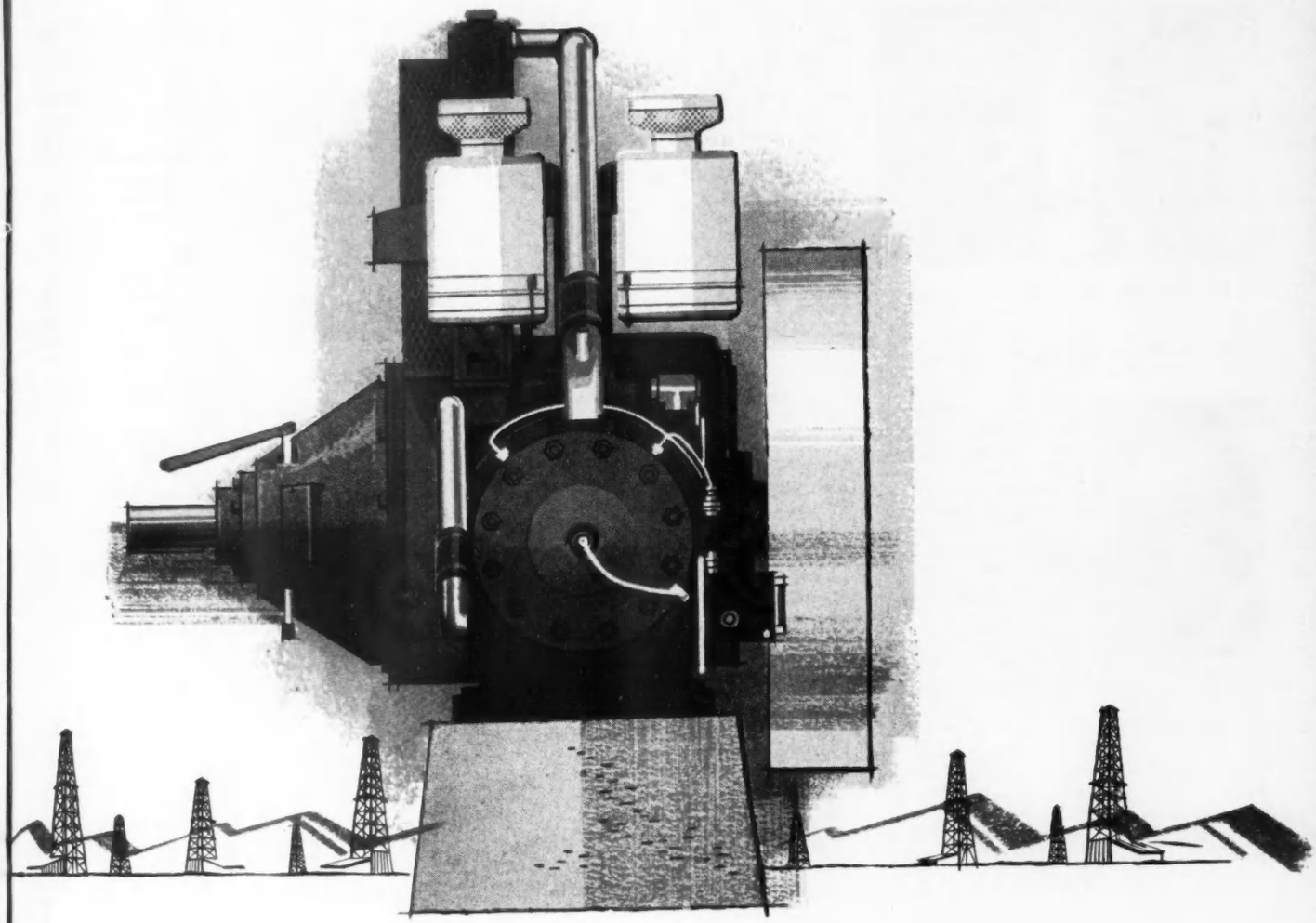

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J. L. Wadlow

P. C. Thomas

J. L. Wadlow, East Coast general sales manager of **Shell Oil Company**, was named vice president. The new vice president will continue to direct the company's operations in marketing divisions centered in Albany, Atlanta, Baltimore, New Orleans, Boston and New York under the general direction of **J. G. Jordan**, vice president for Shell's nationwide marketing activities. Wadlow joined Shell as a service station salesman in the St. Louis division in 1926. Also named vice presidents were **Selwyn Eddy**, West Coast general sales manager, and **P. C. Thomas**, Midwest general sales manager. Eddy formerly was manager of Shell's marketing division in Los Angeles, Detroit and New York and served as East Coast general sales manager before moving to the West Coast in 1954. Thomas is a former division manager in St. Louis and Los Angeles, and served as general sales manager on both the East and West Coasts before being named Midwest general sales manager in 1954.

Selwyn Eddy

•

C. J. Long has been named division geophysical supervisor of **Stanolind Oil and Gas Company's** North Texas-New Mexico division. Long replaces **P. D. Balbin** who resigned. He will be in charge of geophysical district offices in Abilene, Tyler, Lubbock and Midland, Texas; and Roswell and Albuquerque, New Mexico. He was hired by Western Geophysical Company, a Stanolind predecessor company, as a computer in 1937, and had worked with various field exploration parties prior to his transfer to the company's general office in Tulsa as seismograph interpreter. Later he was promoted to party chief; field seismograph supervisor; assistant division geophysicist at Oklahoma City and Fort Worth; and district geophysicist at Roswell and Midland.

•

Oceanic Oil Company announced the appointment of **Jack A. Falkenberg**, manager of land and lease, to vice president. Falkenberg joined Oceanic in 1954 after leaving the position of assistant manager of lands, Pacific Coast division of The Texas Company, with which he had been associated for 22 years.

Dan Duncan, consulting engineer, Los Angeles, has established a consulting engineering service specializing in the reduction of drilling contractors' operational, drilling and maintenance of equipment costs. Duncan has had 35 years experience as driller, field engineering with contractors, designing drilling equipment, and acting as consultant on offshore drilling barges and installations. He is a California registered professional mechanical engineer.

Dan Duncan

Capt. L. H. Curtis was appointed to the new position of marine superintendent of the transport department of **Shell Oil Company's** New Orleans exploration and production area.

Capt. Curtis will have the responsibility of directing, supervising and coordinating the marine transportation services for Shell's offshore operations. Capt. Curtis has a background of more than 30 years of marine operations.

•

Audley L. Bailey, president of **Canfield Oil Company**, a subsidiary of The Standard Oil Company (Ohio) with headquarters in Cleveland, Ohio, is retiring after 43 years of service with Canfield, after eleven years as president.

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P. O. Box 7986—University Station
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New Books

NATIONAL OIL SCOUTS AND LANDMEN'S YEAR BOOK, National Oil Scouts and Landmen's Association, L. J. Adams, editor.

Volume 26 of the Year Book, a review of 1955 oil and gas field development in the U. S. and Canada, covers every oil producing area in North America, listing field production, exploratory and wildcat activity, new pays, extensions, and blocks assembled. The book's information is gathered by the association's district editors each year. The book contains 1208 pages and weighs five pounds, one of the largest volumes ever published by the association in its 26 years of year book preparation.

•

SAFE PRACTICES IN WELL-PULLING OPERATIONS, American Petroleum Institute, 50 West 50th Street, New York, N. Y., $1.

To help service crews protect themselves, and to lower the accident rate in well-pulling operations, the American Petroleum Institute has revised and updated its manual on safety in well-pulling.

The new manual replaces the first edition published more than 20 years ago. Considerably expanded and liberally illustrated, it provides service crews with up-to-the minute information on how to avoid the many costly accidents which have contributed to the all-too-frequent injuries involved in well-pulling.

It was prepared by the Committee on Safety in Drilling and Production Operations, a part of the Central Committee on Accident Prevention.

•

PETROLEUM REVIEW, WINKLER COUNTY, TEXAS, Phifer Petroleum Publications, P. O. Box 20024, Houston 25. $10.

This latest reference book on West Texas oil production, sixth in a series that already has covered Andrews, Gaines, Ector, Crane and Yoakum and Terry counties, is being released in the thirtieth anniversary year of the discovery of oil in Winkler County in the Hendrick field July 16, 1926. Since then 42 oil and gas fields have been discovered with a combined production total of almost a half billion barrels of oil.

Field hearing files of the Railroad Commission of Texas are the major source of information for the book which includes subsurface structure maps on many of the fields and logs of discovery wells.

•

UNDERGROUND STORAGE OF LIQUID PETROLEUM HYDROCARBONS IN THE UNITED STATES, Interstate Oil Compact Commission, P. O. Box 3127, Oklahoma City 5. $1.

The two-part publication, complete with illustrations and tabulations, is the result of approximately four years' study by the IOCC Research Committee, working in cooperation with state committees throughout the U. S.

Part I summarizes general conditions for underground storage which apply throughout the U. S., dealing primarily with geologic and engineering aspects of underground storage.

Part II is a compendium of state reports describing storage projects now in operation and possibilities for other storage facilities in 42 states.

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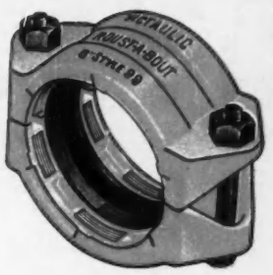

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DEATHS

R. B. Grainger, veteran Byron Jackson Oil Tools representative, died June 10. He served Byron Jackson in sales operations on the Gulf Coast and in California and as an export representative. Later, he was active in sales work for Byron Jackson Oil Tools in the Los Angeles Basin-San Joaquin area. Most recently he was the representative for Byron Jackson Oil Tools in the California coastal areas.

Walter L. Ives, 64, independent oil operator, died July 1 in a Siloam Springs, Ark., hospital. He had been active for many years in the Mid-Continent area.

Wilson (Cotton) Metcalf, 51, veteran employe of The Texas Company died July 1 in a Tulsa hospital after a brief illness. He had been a draftsman, landman, oil scout and purchasing and sales representative for Texaco.

John William Fulbright, president of the Intracoastal Canal Association of Louisiana and Texas, died July 14 in Beaumont, Texas.

William H. Burke, 49, area production manager for Shell Oil Company died July 28. He joined Shell in 1932. All of his career had been devoted to the mid-continent area, having served in various engineering capacities in McPherson, Kansas; Wichita Falls, Texas; Oklahoma City and Tulsa, Okla. He was first named area production manager in 1947.

Ralph H. Espach, chief branch of petroleum, Region III, U. S. Bureau of Mines, died August 6. He had written numerous publications relating to the production of oil. In 1954 after 30 years association with the Bureau of Mines he was presented the highest award of the Department of the Interior, the Distinguished Service Award.

George Rider, 67, West Los Angeles oil executive, died August 7. He was vice president of the Sun Oil Company of California.

H. F. (Fred) Owen, 68, a West Side pioneer oil man, died August 3 in Santa Barbara, Calif. Owen, was general manager of Berry Oil Company. He joined the company in 1907.

Harry Basher, 68, pioneer oil man, died at a hospital in Bakersfield, Calif. He worked as a roustabout, first in the Kern River fields in California and became eventually superintendent on several leases. He then acquired several of his own wells in Kern River and later developed one at Fruitvale.

Col. John Henry (Jack) Lapham, 71, a director of The Texas Company, was killed August 2 when his plane crashed south of Bandera, Texas.

Frank Steele Craver, Sr., 78, independent Tulsa oil producer, died July 31. Craver was the discoverer and developer of "Petrometer," a direct method of oil location. A petroleum engineer, geologist and geophysicist, Craver had appeared in Who's Who in the Western Hemisphere and Who's Who in Engineering.

Charles E. Wilcox, 89, died recently. He spent more than 70 years of his life in the oil industry. He is credited with drilling the first producing well in Utah and with perfecting several drilling tools which improved drilling facilities.

Richard H. Ernest, independent oil producer, died August 13 at Shreveport, La. He had operated in Nevada, Oklahoma, Kansas and West Texas before going to Louisiana.

Seth W. Herndon, Sr., 59, president and founder of Herndon Oil Drilling Company, died August 21. During World War II he served as District 2 director of natural gas and gasoline for the Petroleum Administration for War.

Lloyd R. Hawley, president of Big West Oil Company of Montana, died August 22 at Spokane, Wash.

George Benedict Lamb, 60, a geophysicist and head of Gulf Oil Corporation's exploration operations in seven states and the Gulf of Mexico, died September 20 in his office in the Gulf Building in Houston. He had been with Gulf since 1929.

Ralph Wygle, assistant district superintendent of the Illinois district of The Texas Company at Salem, Ill., and widely known in Oklahoma and Kansas where he worked for a long time, died at Marion, Kansas, September 17.

Samuel Goldman, 86, died Septemper 15 at a Los Angeles hospital. He was president of the Petroleum Supply Company of Bakersfield and also of the Lilly Realty Corp.

George Koegler, 52, deputy general counsel, Standard Oil Company (New Jersey) died in a New York hospital on September 14. Koegler had held this position since November, 1955, when he completed 12 years service with the Law department of Standard.

Ralph E. (Ed) Johnson, 39, Tulsa, well known in Mid-Continent drilling mud circles and representative for Indian Drilling Mud Company, died September 12 in a Tulsa hospital.

Dr. Frederick Squires, 77, consulting engineer for the Forest Oil Corporation, and petroleum engineer emeritus at the Illinois State Geological Survey, died August 23 at his home in Urbana, Ill. He was a pioneer in new methods of recovering oil from reservoir rocks and had been cited many times for his work in the technology of secondary oil recovery.

Sam P. Shelburne, 68, of Oklahoma City, died September 7. He was president of the Shelburne Oil Company and had been an independent oil operator since 1918.

George Milton Harris, 84, retired superintendent of crude oil purchasing for Stanolind Oil and Gas Company, died August 30, in Tulsa. At one time he was general superintendent for the Sinclair Oil Company.

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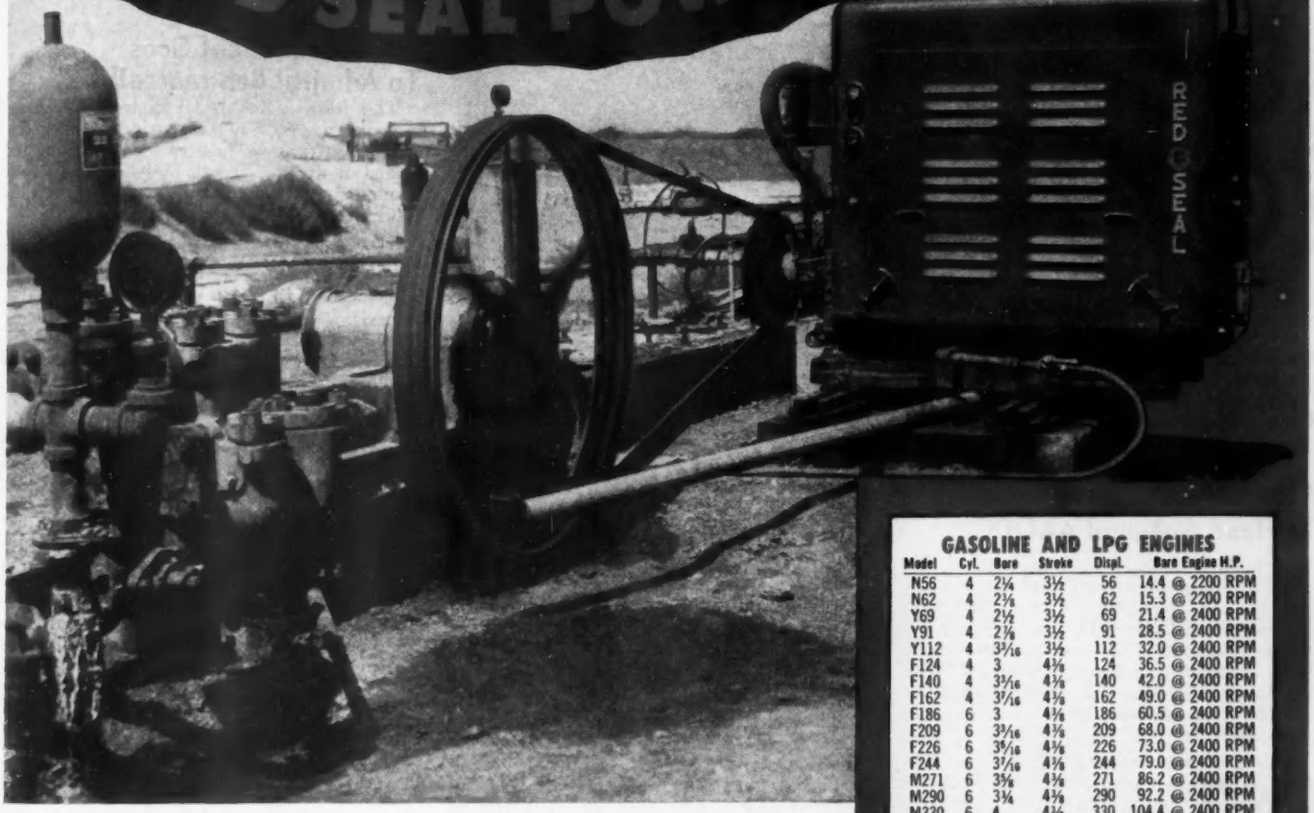

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N62	4	2⅜	3½	62	15.3 @ 2200 RPM
Y69	4	2½	3½	69	21.4 @ 2400 RPM
Y91	4	2⅞	3½	91	28.5 @ 2400 RPM
Y112	4	3 1/16	3½	112	32.0 @ 2400 RPM
F124	4	3	4⅜	124	36.5 @ 2400 RPM
F140	4	3 1/16	4⅜	140	42.0 @ 2400 RPM
F162	4	3 1/16	4⅜	162	49.0 @ 2400 RPM
F186	6	3	4⅜	186	60.5 @ 2400 RPM
F209	6	3 1/16	4⅜	209	68.0 @ 2400 RPM
F226	6	3 1/16	4⅜	226	73.0 @ 2400 RPM
F244	6	3 1/16	4⅜	244	79.0 @ 2400 RPM
M271	6	3⅜	4⅜	271	86.2 @ 2400 RPM
M290	6	3¼	4⅜	290	92.2 @ 2400 RPM
M330	6	4	4⅜	330	104.4 @ 2400 RPM
M363	6	4	4 13/16	363	128.9 @ 2800 RPM
B371	6	4⅛	4⅜	371	110.0 @ 2400 RPM
B427	6	4 1/16	4⅜	427	127.0 @ 2400 RPM
G134	4	3⅛	4⅜	134	34.2 @ 2000 RPM
G157	4	3⅜	4⅜	157	40.0 @ 2000 RPM
E201	4	3⅝	4⅜	201	65.4 @ 2400 RPM
H227	4	3⅜	5½	227	54.0 @ 1800 RPM
H243	4	3¼	5½	243	57.9 @ 1800 RPM
H260	4	3⅜	5½	260	62.0 @ 1800 RPM
H277	4	4	5½	277	66.4 @ 1800 RPM
K363	6	4	4 13/16	363	123.0 @ 2400 RPM
J382	4	4½	6	382	74.0 @ 1400 RPM
T371	6	4⅛	4⅝	371	119.0 @ 2400 RPM
T427	6	4 1/16	4⅜	427	140.0 @ 2400 RPM
U501	6	4½	5¼	501	159.0 @ 2400 RPM
R513	6	4½	5⅛	513	164.3 @ 2400 RPM
R572	6	4¼	5⅛	572	182.4 @ 2400 RPM
R602	6	4⅜	5⅛	602	191.7 @ 2400 RPM
V603	8	4¼	4¼	603	220.0 @ 2800 RPM
S749	6	5¼	5½	749	217.0 @ 2200 RPM
S820	6	5⅛	5½	820	237.0 @ 2200 RPM

CUSHIONED POWER DIESEL ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
ZD129	4	3¼	3⅞	129	34.0 @ 2000 RPM
GD157	4	3⅜	4⅛	157	39.0 @ 2000 RPM
*ED201	4	3⅝	4⅛	201	45.8 @ 2000 RPM
HD243	4	3¼	5½	243	55.0 @ 2000 RPM
*HD260	4	3⅜	5½	260	59.0 @ 2000 RPM
*HD277	4	4	5½	277	63.2 @ 2200 RPM
*JD382	4	4½	6	382	72.5 @ 1600 RPM
TD427	6	4 1/16	4⅛	427	106.0 @ 2000 RPM
RD572	6	4¼	5⅛	572	154.0 @ 2000 RPM
VD603	8	4⅛	4¼	603	175.0 @ 2600 RPM
SD802	6	5 1/16	5½	802	202.0 @ 1800 RPM

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What's Happening

AMONG INDUSTRY ASSOCIATIONS

The new officers of the AAODC are, seated left to right, Earle C. Hellums, Brad Mills, Jack H. Abernathy, J. U. Teague, and J. D. Huffaker. Standing, left to right, are W. L. McClusky, Frank E. Frawley, D. B. Ferguson, W. C. Fatjo, Don Slape, and Marion S. Church. Not pictured are M. M. Brantly, Will I. Lewis, Jr., Herbert Woolf, and R. C. Sharp.

Abernathy and Teague To Head National AAODC

Jack Abernathy, vice president of Big Chief Drilling Company, Oklahoma City, was elected president of the American Association of Oilwell Drilling Contractors at the 16th annual meeting in Fort Worth. J. U. Teague, president, Columbia Drilling Company, Houston, was selected by the board of directors as the national vice president.

Other officers named by the membership, include: vice president Cable Tools: D. B. Ferguson, Ferguson Drilling Company, Oklahoma City; vice president, New Mexico and West Texas: M. M. Brantly, Brantly Drilling Co., Inc., Midland; vice president, Illinois, Michigan, Indiana and Kentucky: Don Slape, Don Slape Drilling Co., Olney, Ill.: vice president, Gulf Coast; Earle C. Hellums, Gracey-Hellums Corporation, Houston; vice president, Central Mid-Continent: Frank E. Frawley, Frank Frawley Drilling Co., Tulsa; vice president, Rocky Mountains: Will I. Lewis, Jr., Will I. Lewis Drilling Co., Mt. Vernon, Ill.; vice president, Well Servicing: W. C. Fatjo, W. C. Fatjo Drilling Co., Lafayette, La.; vice president, Cretaceous and Tertiary Basins: Herbert Woolf, Woolf & Magee, Inc., Tyler, Texas; vice president, North and West Central Texas: J. V. Huffaker, F. W. A. Drilling Co., Wichita Falls, Texas; and vice president, Calif.: R. C. Sharp, Drilling & Exploration Company, Los Angeles, Calif.

Re-elected were W. L. McClusky, secretary-treasurer; Brad Mills, executive vice president; and Marion S. Church, general counsel.

Abernathy has served the AAODC as vice president of the Central Mid-Continent division, chairman of the Central Oklahoma chapter, chairman of the Research and Education Committee and has been a member of the Publications and Rotary Drilling Committees.

Prior to his election as national vice president, Teague has ben vice president of the Gulf Coast area, chairman of the Rotary Drilling Committee and chairman of the Houston chapter for association.

API 36th Annual Meeting To Convene in Chicago

November 12 through 15 is the date set for the 36th annual meeting of the American Petroleum Institute in Chicago. An expected 7000 will register for the meeting.

Secretary of the Interior Frederick A. Seaton, API President Frank M. Porter, International Business Machines President Thomas J. Watson, Jr., and Frank O. Prior, president of Standard Oil Company (Indiana), will be the principal speakers at the two general sessions on November 14 and 15.

The presentation of an award, a "Gold Medal for Distinguished Achievement," which the Institute awards to some outstanding individual who has contributed much to humanity through the petroleum industry, will be resumed this year.

Among the prominent oil men who will address some of the sessions are L. F. McCollum, president of Continental Oil Company, Houston; John G. McLean, vice president of Continental, Houston; and Richard Rollins of Atlantic Refining Co., Philadelphia, 1956 national chairman of the Oil Industry Information Committee.

Hoover, Jr., Receives Engineering Medal

The Hoover Medal for 1956 will be presented to Herbert Hoover, Jr., undersecretary of state.

The Hoover Medal was named after former President Hoover, father of the undersecretary and, in 1930, its first recipient. It is sponsored by four major engineering organizations, the American Society of Civil Engineers, the American Institute of Mining, Metallurgical, and Petroleum Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. These are known, generally, as the Four Founder Societies.

John Fritz Medal Goes To Admiral Ben Moreell

The John Fritz Medal Board of Award, representing four major national engineering organizations, has announced that its award of the medal will be to Admiral Ben Moreell, chairman of the board of Jones & Laughlin Steel Corporation and, in World War II, organizer and commander of the Navy's Seabees.

The award is sponsored jointly by the American Society of Civil Engineers, the American Institute of Mining, Metallurgical, and Petroleum Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. Presentation of the gold medal, and certificate signifying the honor, will be made October 17 in Pittsburgh during the national convention of the American Society of Civil Engineers.

Geological Society Elects Forsyth New President

The newly elected officers of the Indiana and Kentucky Geological Society are Roderick J. Forsyth, an independent geologist of Evansville, Ind., president; W. W. Hagan, an independent geologist from Owensboro, Ky., vice president; and Ed Wilson, geologist for Great Lakes Carbon Corporation in Evansville, secretary-treasurer.

Members of the executive committee are James W. Kendall, G. E. Ebmeyer, and Roscoe E. Wise.

Dallas Executive Elected Texas Trade President

Charles E. Simons, Dallas, executive vice president of the Texas Mid-Continent Oil & Gas Association, has been named president of the Texas Trade Association Executives.

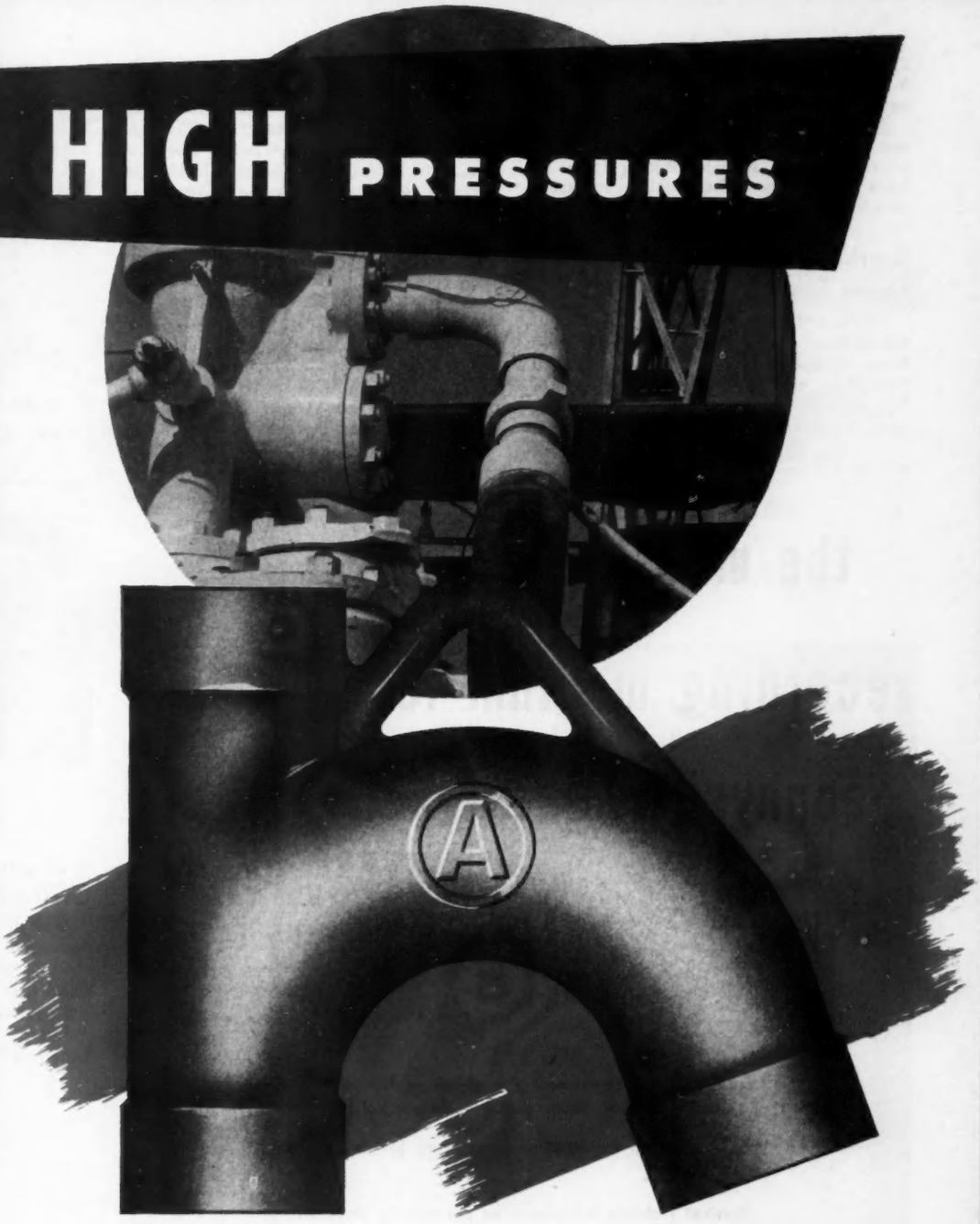
C. E. Simons

The TTAE is composed of executive officers of more than 80 Texas trade associations and related chapters which represent most fields of commercial and industrial activity.

Controllers Institute Adds Three to Membership

Three men have been elected to membership in the Controllers Institute of America. They are Don E. Burkitt, secretary-treasurer, Schermerhorn Oil Corporation, Tulsa; James W. Pyle, assistant treasurer, Canadian Superior Oil Company of

FOR HIGH PRESSURES



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Established in 1931, the Institute is a non-profit management organization of controllers and finance officers from all lines of business. The total membership exceeds 4500.

Southern California ASME Elects Fontana Chairman

Frank J. Fontana, chief engineer, Refining division, Richfield Oil Corporation, has been elected chairman of the Southern California section, American Society of Mechanical Engineers, for the 1956-57 year, it was announced. He succeeds R. M. Hatfield, vice president, Combustion Engineering Corporation.

Other new officers elected are Shuman H. Moore, district manager of the Los Angeles office of Foster Wheeler Corporation, vice chairman; and George E. Hallen, engineer, Offco Construction Company, secretary treasurer. Elected to the executive committee were Raymond C. Baird, consulting engineer; J. E. Wolf, supervisor of Turbo Machinery department, North American Aviation Corporation, Rocketdyne division; G. W. Ehrhart, president of Ehrhart Associates, Inc.; Norman Lynn, president, Lynn-Western, Inc.; A. B. Fredhold, Jr., EMSCO Derrick and Equipment Company; and George F. Weismann, General Petroleum Corporation.

H. K. Phipps

W. G. Tierney

Kansas Petroleum Group Elects Phipps President

H. K. Phipps, manager, Central Pipe Line division, Socony Mobil Oil Company, Wichita, was elected chairman of the Executive committee of the Kansas Petroleum Industries Committee.

C. E. Holmes

W. G. Tierney, president of the Derby Refining Company, Wichita, was elected vice chairman. C. E. Holmes was retained as executive secretary. Phipps has been a member of the Executive Committee since its formation in July, 1936.

National Petroleum Elects Officers at 54th Meeting

Guy B. Hunter, president of Quaker State Oil Refining Corporation, was re-elected president of the National Petroleum Association at the 54th annual meeting at Atlantic City recently.

Other officers re-elected at the same board of trustees meeting were Paul R. Beck, first vice president; and Rexford S. Blazer, second vice president. Beck is with Pennsylvania Refining Corporation, Butler, Penn., and Blazer is with Ashland Oil and Refining Company, of Ashland, Ky.

Hunter was also re-elected treasurer of NPA.

Texas Mid-Continent Honors Anderson, Belt

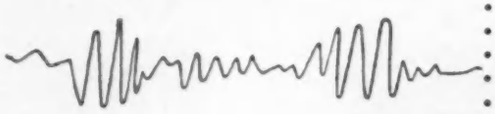
The Distinguished Service Award committee of the Texas Mid-Continent Oil & Gas Association has selected Ben C. Belt, recently retired from Gulf Oil Corporation, of Houston and R. B. Anderson, president of Ventures Ltd., New York, to receive this year's awards for outstanding service to the oil industry.

Ben Belt will be presented his award on the first morning of the annual meeting, October 2, Rice Hotel, Houston. Bob Anderson will receive his on the second morning, October 3.

M. S. Hauser Will Head OIIC's PR Program

M. S. Hauser, public relations director of The Ohio Oil Co. was elected 1957 national chairman of the Oil Industry In-

the most PERMANENT ACCESSIBLE recording medium for geophysical data



irish BRAND FERRO-SHEEN GEOPHYSICAL RECORDING TAPE

(now in field use more than all other brands combined)

irish FERRO-SHEEN recording tape, belts and loops are sweeping the field in modern recorder instrumentation for geophysical exploration. Here is why:

Storage life is extended on magnetically permanent irish geophysical tape and belts.

Physical stability is increased on permanently plasticized, non-embrittling irish geophysical tape and belts.

Toughness under use is assured by the du Pont Mylar base of irish geophysical tape and belts.

Special applications are developed on request by the ORRadio Industries research staff for irish geophysical tape and belts.

AND . . . the exclusive irish FERRO-SHEEN Process puts a uniquely smooth, non-shedding magnetic oxide coating on the tape, which will not wear out or gum up recorder heads like conventional oxide coating.

ORRADIO INDUSTRIES fabricates belts for **TECHNO** and **AMPEX** recorders.

ORRADIO INDUSTRIES, Inc., Opelika, Alabama

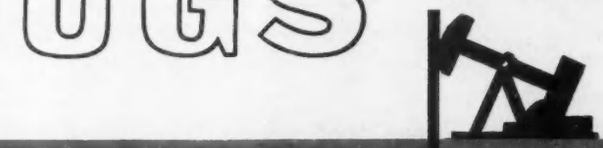
World's Largest Exclusive Magnetic Tape Manufacturer

Houston, Texas, 208 Sidney St. . . . . . **WAlnut 3-8720**
R. E. Salter, Mgr. Special Geophysical Office

Dallas, Texas, Box 12204 . . . . . **EMerson 3991**
W. R. Hays, Jr., N. Texas & Okla.

Los Angeles, California, 4217 W. Jefferson Blvd. . . **REpublic 1-2238**
Claude Erlanger, Mgr., California

BUGS IN YOUR WATER FLOOD?



X-CIDE

INDUSTRIAL BACTERICIDE CONTROLS THEM

X-CIDE bactericide prevents the growth of anaerobic and aerobic micro-organisms in both fresh and salt water systems. It is particularly effective against the sulfate reducing organisms which convert sulfates to corrosive hydrogen sulfide. Hydrogen sulfide also leads to the plugging of injection formations by causing soluble iron to precipitate as insoluble iron sulfide.

In addition to its bactericidal action, X-CIDE is a highly effective corrosion inhibitor. The chart (right) shows how effectively X-CIDE acted to reduce corrosion and bacteria in a Texas water flood operation.

For complete information on X-CIDE, ask your Tretolite field service engineer.

CORROSION RATE

Sampling Point	Untreated 1st Week Iron Count ppp	Treated with X-CIDE 2nd Week Iron Count ppm	Treated with X-CIDE 3rd Week Iron Count ppm
A	10.6	0.2	1.7
B	14.1	1.5	0.7
C	17.6	0.2	0.2
D	14.5	0.2	3.4
E	52.8	0.9	0.8
F	9.7	0.3	0.2
Pit Outlet G	18.5	1.6	1.5
Hay Tank H Treater	3.5	0.6	1.0

BACTERIA COUNT

Sampling Point	Untreated 1st Week Sulfate* Reducers	Treated with X-CIDE 2nd Week Sulfate* Reducers	Treated with X-CIDE 3rd Week Sulfate* Reducers
A	500	5	50
B	1	0	0
C	500	4	1
D	1,100	3	30
E	10	10	35
F	10,000	50	60
Pit Outlet G	100,000	400	3
Hay Tank H Treater	10,000	0	1

*Bacteria colonies per milliliter of water.

Chemicals and Services for the Petroleum Industry

DESALTING • DEMULSIFYING • CORROSION PREVENTING • SCALE INHIBITING • FUEL OIL ADDITIVES • WATER DE-OILING • PARAFFIN REMOVING • PRODUCTION STIMULATING BACTERICIDES • METAL CONDITIONERS

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

369 Marshall Avenue, Saint Louis 19, Missouri

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X 56-21

Seeco-Mul saves drilling costs.

Compared to ordinary emulsifiers, Seeco-Mul will lower your maintenance costs, and, because of the superior properties in Seeco-Mul you will:

Get faster penetration, less balling on bottom, less torque on the drill stem, better control of heaving and sloughing shales,

longer life from collars, bits and tool joints, pump liners, and other equipment. Many leading mud engineers recommend Seeco-Mul to improve hole conditions, to

get a better completion, and make a better well. Seeco-Mul is packaged in sturdy, 50-pound sacks that are easy to handle around the rig, and any qualified mud engineer can use it without special equipment or special instructions.

Seeco-Mul Makes a Good Mud Better.

Ask your local mud dealer, or write to Crossett Chemical Company, Crossett, Arkansas.

CROSSETT

Seeco-Mul

DRILLING MUD EMULSIFIER

formation Committee, the petroleum industry's public relations program. Hauser succeeds Richard Rollins, secretary of The Atlantic Refining Co. He will assume the chairmanship at the OIIC's next meeting in New York in December.

Vice chairman elected were Kerryn King, The Texas Company, New York; Dwight M. Hills, Sinclair Refining Company, Atlanta, Ga.; James M. Patterson, Standard Oil Company (Indiana), Chicago; Joe T. Dickerson, Shell Pipe Line Corp., Houston; G. Stewart Brown, Standard Oil Company of California, San Francisco.

John S. Cooke, American Petroleum Institute, New York, was re-elected secretary.

Desk and Derrick Picks New Officers, Directors

Mrs. Ida B. Griffith, Humble Oil & Refining Company, was elected president of the Desk and Derrick Club of Houston for the year 1956-57. She previously has served as first vice president and chairman of the Public Relations committee as well as being a member of various committees.

Mrs. Ida B. Griffith

Other newly elected officers are Miss Louise Sherrill, first vice president, Brewster-Bartle Drilling Company; second vice president, Miss Anna Bob Taylor, Gulf Oil Corporation; recording secretary, Miss Alice Newcomer of Shell Oil Company; corresponding secretary, Mrs. Carol Beckwith of Cities Service Oil Company; and treasurer, Mrs. Olivia May, Humble Oil & Refining Company.

The following new directors were also elected: Miss Sophie Edmundson, Miss Janet Rother, Miss Kittie Skelton and Miss Mary Woolford. These directors will serve for two years.

NACE Western Region To Meet at Long Beach

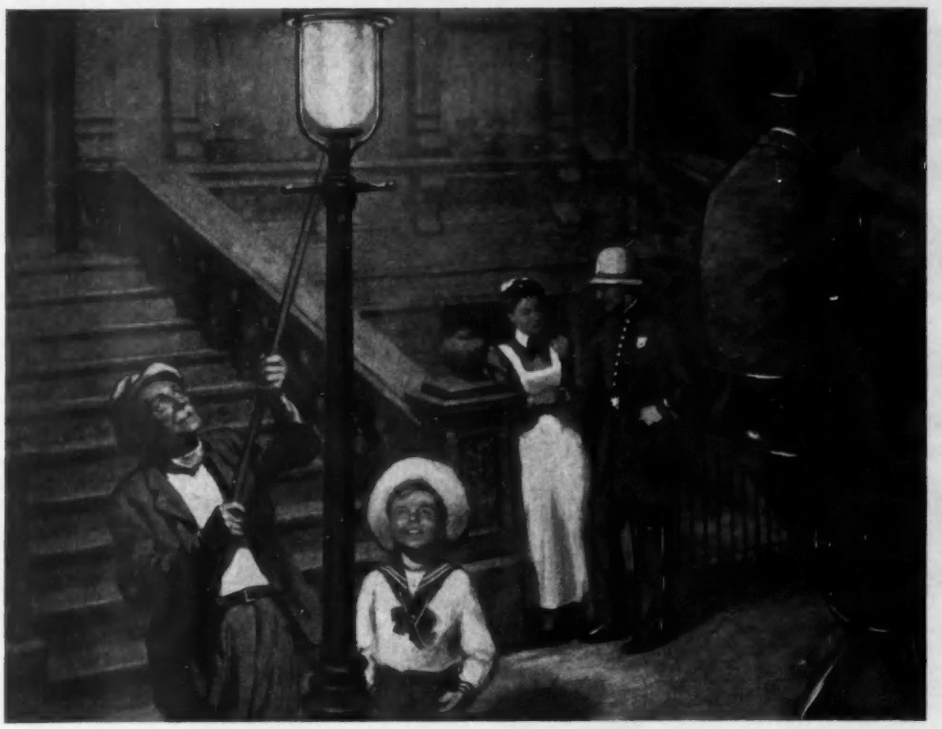
Preston W. Hill, Signal Oil and Gas Company, Long Beach, Calif., has been named general chairman of the 1956 fall meeting of National Association of Corrosion Engineers Western Region. The meeting will be held November 15-16 at the Lafayette Hotel. R. E. Hall, Union Oil and Gas Co., Brea, Calif., is program chairman.

Stanolind's Nash Selected Editor of the Year

William J. Nash has been named "Editor of the Year" by the Tulsa chapter of the Society of Associated Industrial Editors.

Nash is publications supervisor for Stanolind Oil and Gas Company, whose employe magazine, Horizons, was awarded top honors in its class by the International Council of Industrial Editors this year.

 (For more data on advertised products, use Readers' Service blue cards, last page this issue.)



gas has come a long way...

50 years ago... a yellow haze in the streets.

Today, natural gas is a 14 billion dollar industry... the nation's sixth largest. Serving 100 million people... over a hundred thousand industrial plants. Supplying one quarter of the nation's heat and energy. Made possible by pipeline transportation.

Tennessee Gas, the nation's longest pipeline, brings nature's finest fuel from the gas-producing Southwest to the densely populated East.

Hauls it safely, cheaply, dependably... 2200 miles across 15 states... a long way to serve America.

Built-in Oven | Home Heating-Cooling | Cooking Range | Water Heating

Today natural gas, shipped by long distance pipeline to millions of homes, enables modern gas appliances to provide easier, healthier living throughout America.

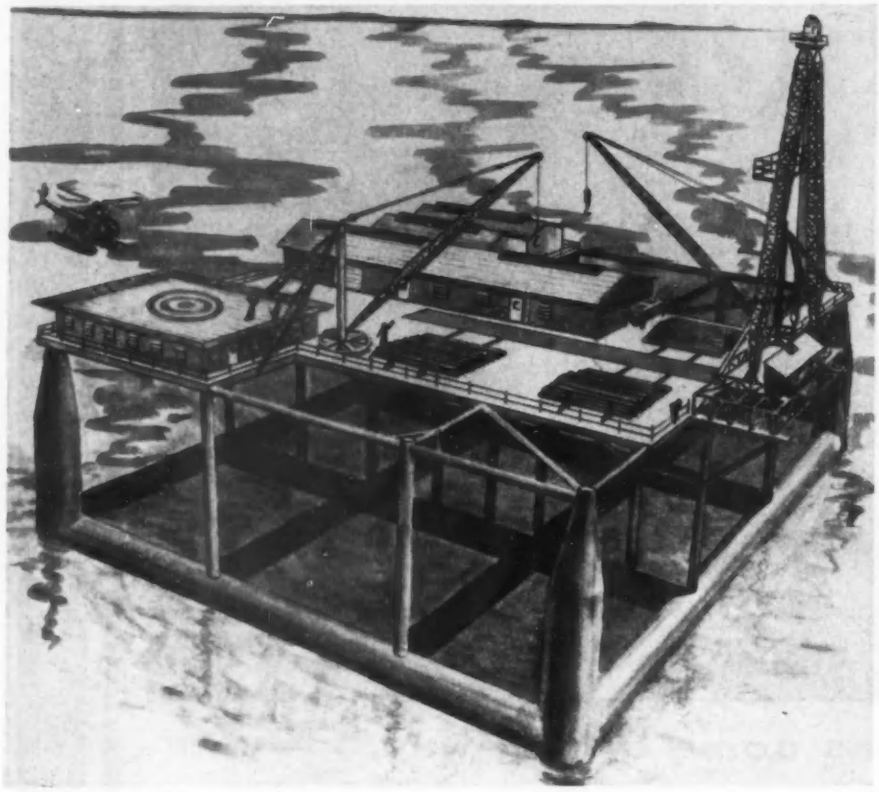
TENNESSEE GAS
TRANSMISSION COMPANY
AMERICA'S LEADING TRANSPORTER OF NATURAL GAS
HOUSTON, TEXAS

One of a series of advertisements appearing in full color in national publications.

And keeps going places... Advertisements like this tell the public about the constantly expanding service provided by the natural gas industry... point out the great strides made in assuring adequate supplies and the modern convenience of gas to millions.

TENNESSEE GAS TRANSMISSION COMPANY
HOUSTON, TEXAS

Companies in the News



Note the tapered stabilizing columns on the corners that are 22 feet in diameter at the base. The huge "T"-shaped Texas deck with the drilling floor extending out 55 feet from the platform is a unique feature of this newest addition to offshore drilling structures.

KERR McGEE OIL INDUSTRIES, INC., had the first of two new, identical, offshore drilling units completed in the yards of Ingalls Ship Building Corporation, Pascagoula, Miss. The new deep water drilling barge designated as Kermac Rig 46, is of a unique design. The barge hull is constructed in a grid pattern of tubular members 14 feet 6 inches in diameter. The over-all dimensions are 202 feet by 242 feet, with the working level 100 feet above the base line. The unit will be capable of operating in the open waters of the Gulf to depths of 70 feet. Stabilizing columns on the four corners are 22 feet in diameter for the lower 64 feet tapered to 5 feet in diameter in the upper 36 feet. There are 20 support columns 42 inches in diameter and 2 support columns of 48 inches diameter. The "T" shaped Texas deck is 181 feet in width at its widest point and 228 feet 6 inches in length. The crew quarters and engine housing are on the cross bar of the "T" and the drilling mast and drawworks are located at the base of the "T." The cross bar of the "T" is 67 feet 4 inches in width and the base of the "T" is 78 feet in width. The box girder structural members extend 55 feet beyond the main platform and support the drilling substructure, mast, drawworks, rotary table and other derrick floor equipment. By means of hydraulically operated rams, the entire cantilevered structure may be skidded longitudinally and transversely to fixed positions for multi-well drilling. Up to six wells may be drilled without relocating the barge. The drilling mast is also designed and equipped to be used as a construction boom for setting protection and production platforms. Ample modern air-conditioned quarters for 50 persons are provided in a single level structural steel house containing 3600 square feet of office, dining, sleeping and recreation space. A helicopter landing port is located atop the quarters building. Kermac Rig 46 is powered by three 875 horsepower diesel engines, each driving two 500 kilowatt d.c. generators. The drilling rig is fully diesel electrical and is adequate for drilling beyond present record depths. There are two 1000 horsepower pumps, each powered by two 625 horsepower electric motors. A smaller pump is provided for mud mixing. A double drum drawworks of 1600 horsepower rating is driven by two 625 horsepower unitized motors, while the rotary table is driven independently by a 625 horsepower motor. All of these motors are interchangeable. The mast is 151 feet high with a 30-foot base, and has a capacity of 750,000 pound hook load. It is designed to withstand winds of up to 130 miles per hour. Mud tanks will hold 800 barrels of liquid. The mud weight material is stored in one 2400 cubic foot bin with additional space on the deck for storage of upwards of 5000 sacks in 50 sack buckets. Cementing and logging equipment is provided as standard equipment. The commissioning of Kermac Rig 46 took place on Oct. 24, 1956. The rig is under long term contract to drill for a major offshore oil and gas producing company and is expected to be placed in service about Nov. 1, 1956.

AMERICAN PETROFINA INCORPORATED has acquired **PANHANDLE OIL CORPORATION** assets through the purchase of 600,000 shares of Panhandle stock. American Petrofina announced the following slate of officers. **Harry A. Jackson,** president, is a veteran of 35 years of oil business experience, mostly with Tidewater Oil Company. His work has been largely in the transportation and foreign fields. Before leaving Tidewater he was a vice president and general manager of eastern operations for that company. **Roger Gilbert** is financial vice president, having been president of Panhandle. He has been with Panhandle since 1951. Gilbert's experience includes 20 years with the investment firm Atlas Corporation, of which he is a former vice president. **W. D. Heath Eves** is vice president of American Petrofina. His former affiliations include Anglo-Iranian Oil Company (now British Petroleum) and Foster-Wheeler Corporation.

•

NEWMONT OIL COMPANY will join **MONTEREY OIL COMPANY** in the latters' California offshore oil search. Newmont Oil is a subsidiary of Newmont Mining Company, also active in exploration in the offshore Gulf of Mexico. Newmont will now share equally of Monterey's 50 percent interest of the joint offshore California exploration program with The Texas Company. Monterey will continue as operator south of the Ventura-Los Angeles County line. The Texas Company continues as operator of the program north of that line.

•

CONTINENTAL OIL COMPANY has awarded 11 1956 high school graduates college scholarships. Winners of the 1956 Conoco scholarships are Audrey G. Arnold, Fort Stockton, Texas; MaLinda Howell, Fort Worth; Carolyn Mullins, Houston; Robert Lee Cheek, Odessa, Texas; Elaine H. Carey, Fort Dodge, Iowa; Jean Frye, Calgary, Alberta, Canada; Kenneth B. Carter and Dale S. Collinson, both of Oklahoma City; and Frank S. Frick, Jerry M. Rogers and Nancy Scofield, all of Ponca City, Okla. The 11 students who were awarded the scholarships are sons and daughters of Continental Oil Company employes who won in competition with applicants from 15 states and Canada.

•

BASIN OIL CO. of California's board of directors have accepted an offer from General Petroleum Corporation to purchase its assets, it was announced. Acceptance of the offer is subject to stockholder approval. The acquisition will be for cash, but the amount was not disclosed. Basin stockholders voted June 29 to liquidate the firm.

•

RYCADE OIL CORPORATION has announced that negotiations have been concluded for the acquisition of all the properties and assets previously owned by Progress Petroleum, Inc., and its two subsidiaries—Progress Petroleum Company of Texas and Euromex Oil Co., Inc., all of which have been liquidated. The sale involved the acquisition of an interest in a pipe line, a gasoline plant, and a gross working interest in oil production of 3800 barrels daily from 115 wells. The producing properties, leasehold interest, and mineral fees included in the sale are located in Texas, Louisiana, New Mexico, Colorado, Wyoming, Oklahoma and Kan-

sas. A new company, Midhurst Oil Corporation, formed to hold these properties, and will be managed by Rycade.

•

SOCONY MOBIL OIL COMPANY, INC. will sponsor a professorship in nuclear science at Princeton University, beginning with the academic year 1956-57. The new chair will be known as the "Socony Mobil Professorship." The company is providing a grant of $17,000 a year to pay the salary of the incumbent as well as research expenses incurred by him or the University with respect to the professorship. In turn the University will establish and maintain the professorship, and will provide an incumbent who, in its judgment, is qualified to fill the chair. The incumbent will be a regular member of the University faculty.

•

PARKER PETROLEUM CO., INC., Ponca City, Okla., purchased the Frederick Petroleum Co., Wilmington, Del., it was announced. The purchase includes 300 barrels daily oil production on over 3000 acres of leases in the Albany area of Shackelford County, Texas.

•

INTERNATIONAL DRILLING COMPANY N. V. has been formed by **Wallace W. March** and **Monty R. Garrison.** IDC was set up on the basis of a company free to operate as such but furnishing American personnel and equipment for operations abroad. Financial headquarters were set up in The Hague and operating headquarters in Rome, Italy, with another office in London. Previously, March was executive vice president of a large contracting company, and Garrison was manager of the European subsidiary of an American contracting company. Manager of operations is **J. N. Biron. B. G. Frazier** is in charge of rig design and trouble shooting. Heading the Holland operations is **G. S. Ormsby;** Italy, **H. R. Stephens;** and Spain, **Jack Connors.** IDC is carrying on drilling operations in Holland, Italian and British Somaliland, Spain and Malta.

•

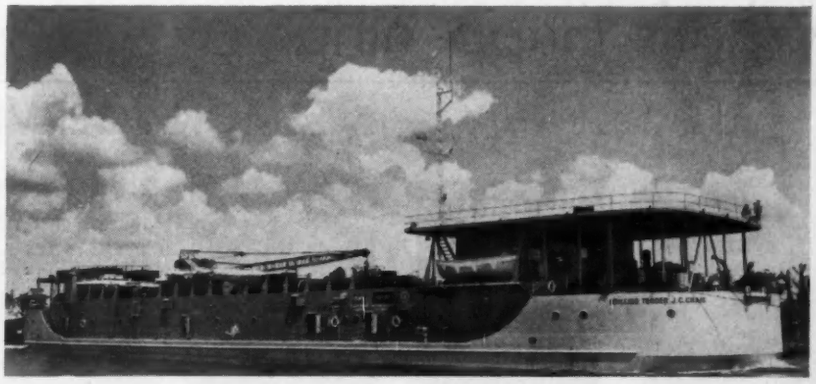
PHILLIPS PETROLEUM COMPANY has acquired 32 British Columbia, Canada, permits from Canada Southern Petroleum Ltd. The majority of the 1,962,074 acres is wildcat. Phillips is paying the full cost of the exploration and continuous drilling program. Canada Southern retained a 50 percent net profit interest by individual blocks.

•

UNION OIL COMPANY OF CALIFORNIA has just completed expansion of a safe and modern marine oil terminal in Los Angeles Harbor. The terminal covers nearly eight acres and has been in operation in the man-made Port of Los Angeles since 1919. Expansion of the big marine terminal at a cost of $2,250,000, practically doubled the capacity of its operations. Added to the new Union Oil Marine Terminal was a 600-foot concrete wharf, which with the previously existing wharf permits the docking of two huge supertankers simultaneously. Wharves are also designed to accommodate barges and other vessels.

•

MAGNA OIL CORPORATION of Dallas announced that the company had acquired the Johnson Ranch Royalty Company, Inc., of Amarillo, Texas, through the purchase of capital stock. The Johnson Ranch Royalty Company, Inc., properties consisted of approximately 5333 acres of producing minerals and appproximately 2450 acres of non-producing minerals, all located in the Panhandle area of Texas, and the properties had 281 oil wells and 134 gas wells located upon them.



CATC Adds to Fleet

The CATC group has accumulated a "Navy" since the start of its drilling operations in 1953. Here is the J. C. Craig drilling tender, the initial member of the CATC fleet. The group has three other tenders similar to the J. C. Craig and a fourth under construction at Orange, Texas. Each tender costs approximately $1,500,000—typical of the staggering investment required to search for oil in the Gulf of Mexico.

•

DELHI-TAYLOR OIL CORPORATION announced the purchase of a 140,000-barrel terminal facility and the opening of a sales office in Fort Lauderdale, Fla. Purchase of the terminal from the Southern States Oil Co. marks Delhi-Taylor's entry into the Southeastern refined-products market. **Edwin E. (Slick) Jackson,** who joined the Delhi-Taylor sales staff in February, will be in charge of the new office. He has been associated with the marketing of petroleum products for more than 20 years.

•

SINCLAIR OIL CORPORATION has contracted to purchase approximately 1,100,000 shares of stock of Texas Pacific Coal & Oil Company, of Fort Worth, Texas. The sale is being made privately by a group consisting principally of investment trusts and institutional type investors in Massachusetts. While the price was not announced, it was indicated that the sale was negotiated at approximately the level of the price as quoted on the Exchange. Texas Pacific Coal & Oil Company has approximately 3,600,000 shares of stock outstanding.

•

SHORELINE PETROLEUM CORPORATION, San Antonio, has purchased all of the oil and gas properties and other fixed assets of Rock Hill Oil and Rock Hill Drilling Company. Rock Hill producing properties are located in Texas, Oklahoma, Kansas, Illinois, Indiana, Nebraska, Montana, Colorado and New Mexico. **John D. Sanford,** who has been in charge of Rock Hill operations, will be executive vice president and general manager of Shoreline. **W. E. (Bill) Richards,** Rock Hill's production superintendent, will be vice president in charge of production and drilling for Shoreline. The entire operating organizations of Rock Hill Oil and Rock Hill Drilling will be kept intact. The only change will be removal of Rock Hill accounting office from St. Louis to San Antonio.

•

GULF OIL CORPORATION has acquired more than 99 percent of Warren Petroleum Corporation capital stock, following the former's offer to exchange shares. The offer expired August 1. Gulf thus in effect acquires control of Warren's 15,000 barrels daily net production, 50 million barrels of crude reserves, and extensive refining, pipe line, and marketing facilities.

•

CHRISTIE, MITCHELL AND MITCHELL, oil operators of Houston, have opened offices in Dallas to handle their expanded North and East Texas operations. Heading geological and exploration activities in the Dallas office will be **Robert Gardner. Dan Peters** will be district landman. The Dallas expansion is a result of combining Christie, Mitchell and Mitchell's Bridgeport and Decatur offices into new quarters in Bridgeport. This office will handle exploration and production in the firm's holdings in the Wise and Jack County area where they have some 250,000 acres under development. At present CM&M have some 95 gas wells shut in on their North Texas spread, comprising one of the largest undedicated gas reserves on the North American continent. Disposition of the gas is awaiting FPC approval of a contract negotiated with Natural Gas Pipeline Company of America. **Ernest Frnka** is general superintendent in the Bridgeport area, with **Milton Monashagin** as area landman and **Owen Miller** as petroleum engineer. Christie, Mitchell and Mitchell also have offices in Billings, Mont., where **James Heath** heads the land department and **Howard Lowe** is geologist, and in Calgary, Alberta, to look after the firm's Canadian operations. An office will soon be opened in Lafayette as headquarters for CM&M's Louisiana activities.

•

THE VICKERS PETROLEUM CO., INC., have moved their Exploration and Production departments to a new location. They are now located in Suite 610, Union Center, Wichita, Kansas.

•

GENERAL PETROLEUM CORPORATION'S Oakland, Calif., storage plant will undergo a $480,000 expansion to provide 150,000 barrels of additional product storage. The new expansion, when complete, will provide a plant capacity of 550,000 barrels.

What's Happening

AMONG SERVICE AND SUPPLY MEN

W. A. Griffin

John W. Mecom

A. M. Iverson, Jr.

L. A. Alaback

J. M. Arceneaux

R. E. Hager

W. J. Peycke, Jr.

Thomas O. Moore

Arthur J. Loose

William S. Howe

L. H. Ingle

John L. Bible

Daniel Orifice Fitting Company, recently announced the election of **W. A. Griffin** to the office of president. He joined Daniel in Los Angeles in 1940, and has been vice president and general sales manager since late 1950. In his new post he succeeds **J. G. Holdenried** who will become executive consultant. With the appointment of Griffin, Daniel Orifice has embarked on an extensive expansion and development program. This program will include an expansion of the Houston plant facilities and a transfer of executive offices from Los Angeles to Houston. He has been active on several measurement research committees of the American Gas Association as a member of the gas measurement committee. In addition, Griffin is a member of the General Committee of the Southwestern Gas Measurement Short Course held each year at the University of Oklahoma.

•

Reed Roller Bit Company board of directors elected Houston independent oil operator **John W. Mecom** a director, succeeding James Anderson, who died July 29. Mecom owns interests in extensive oil producing properties in Texas and south Louisiana, and also operates in Columbia, Honduras and Haiti. He owns Cron and Gracey, a drilling contracting firm, and three manufacturing companies: Cardwell Manufacturing Company, Wichita, Kansas; Boonton Molding Works, Boonton, N. J.; and Polymer Engineering Corporation, Alta Loma, Texas. Also, there are four Mecom Aberdeen Angus Cattle ranches, specializing in the breeding of top quality Angus lines. In 1955, he formed a partnership with San Jacinto Petroleum Corporation, known as Mecom Petroleums, which operates both on and offshore in Louisiana.

The Iverson Supply Co., Tulsa, announces the promotion of **A. M. Iverson, Jr.,** to city sales representative for Oklahoma City. He was formerly a field salesman for the company in Sherman, Texas, and prior to his last assignment had worked as a warehouseman and field representative and store manager.

Other changes announced by Iverson: **H. G. Sledge,** formerly floorman, was promoted to field representative of the Odessa, Texas, store; **John Crichten,** field representative, transferred from Odessa to Sherman, Texas.

•

Lloyd A. Alaback was appointed sales engineer of **Western Supply Company** of Tulsa. Alaback's specific duties with Western will be the sale of Brown-Fintube heat transfer equipment consisting of Brownwald Fintubes, longitudinal fin double-pipe exchangers, tank heaters, tank suction heaters, line heaters, and fired indirect heaters. His territory will include Kansas, Oklahoma and western Missouri.

•

Jules M. Arceneaux has been appointed Louisiana division manager by **Gammaloy, Ltd.,** with headquarters in Lafayette. Arceneaux will handle rental service for Gammaloy non-magnetic survey drill collars for the area with a stock of collars in Lafayette. He was formerly associated with Eastman Oil Well Survey Company and The National Supply Company in Louisiana.

•

R. E. Hager was appointed manager of **Cameron Iron Works of Canada, Ltd.** His headquarters will be in Edmonton where Cameron maintains complete warehousing, assembling and testing facilities. Forging sales engineer before his new appointment, Hager has been with Cameron for 13 years. Prior to joining Cameron, Hager was field engineer with the National Standard Oil Co. and also associated with the McEvoy Co. as a tool engineer and with North American Aviation as chief tool engineer. His duties with Cameron have included development engineering work and at one time he was chief draftsman in charge of design development. He has had considerable field experience in well blowout work.

•

Unit Rig & Equipment Company has announced the promotion of **W. J. Peycke, Jr.** to plant superintendent. He joined Unit Rig in 1953, and has held several key positions in the Engineering department, the most recent being project engineer of drawworks drives. Prior to his affiliation with Unit Rig he was design engineer for Jensen Bros. Mfg. Co., Inc.

•

Thomas O. Moore has joined the staff of **ORRadio Industries, Inc.,** Opelika, Ala., as chief electronic engineer. Moore comes to ORRadio from a tour of duty in Washington, D. C. which included work on the Navy's new atomic submarines. He was an electronic engineer with the joint organization of the Navy department and Atomic Energy Commission. As an instrument specialist he worked on nuclear power applications in the atomic submarine project. As chief electronic engineer, Mr. Moore will head ORRadio's division for development and evaluation of new Irish Brand instrumentation tapes. These include geophysical tape, computer tape for "electronic brain" computers, and an instrumentation tape that records both sound and color pictures for television and movies.

•

Arthur J. Loose has been elected vice president of **Vapor Heating Corporation,** Chicago. Loose has returned to the Vapor headquarters in Chicago after six years in

Houston, where he was vice president in charge of Texsteam Corporation, a wholly owned subsidiary of Vapor Heating Corporation. Loose will continue to be vice president of Texsteam Corporation along with his administrative work as vice president of Vapor Heating Corporation at the company's main office and plant in Chicago. Before coming with Vapor Heating Corporation 17 years ago Loose was with Electro Motive division of General Motors.

•

William S. Howe has been named sales manager for domestic and foreign operations of **Koenig Iron Works, Inc., Houston.** Howe came to the Koenig organization from Toledo, Ohio, where he held an executive sales position with Willys Motors.

•

L. H. Ingle has been elected treasurer of **Lane-Wells Company.** With Lane-Wells since 1945, Ingle has been chief accountant, assistant controller and controller. **Robert L. Walsh,** who has been with Lane-Wells since 1940 has been advanced from chief accountant to assistant controller. **F. E. Miller,** with the company since 1949, replaces Walsh as chief accountant.

•

John L. Bible has been named vice president in charge of gravity, magnetic and radiometric operations of **Southern Geophysical Company,** seismic survey organization. He will headquarter in the firm's Houston offices. Bible is a veteran in the geophysical exploration field, with 20 years experience in surveys, research, instrumentation and interpretation. He was formerly president of Tidelands Exploration Company.

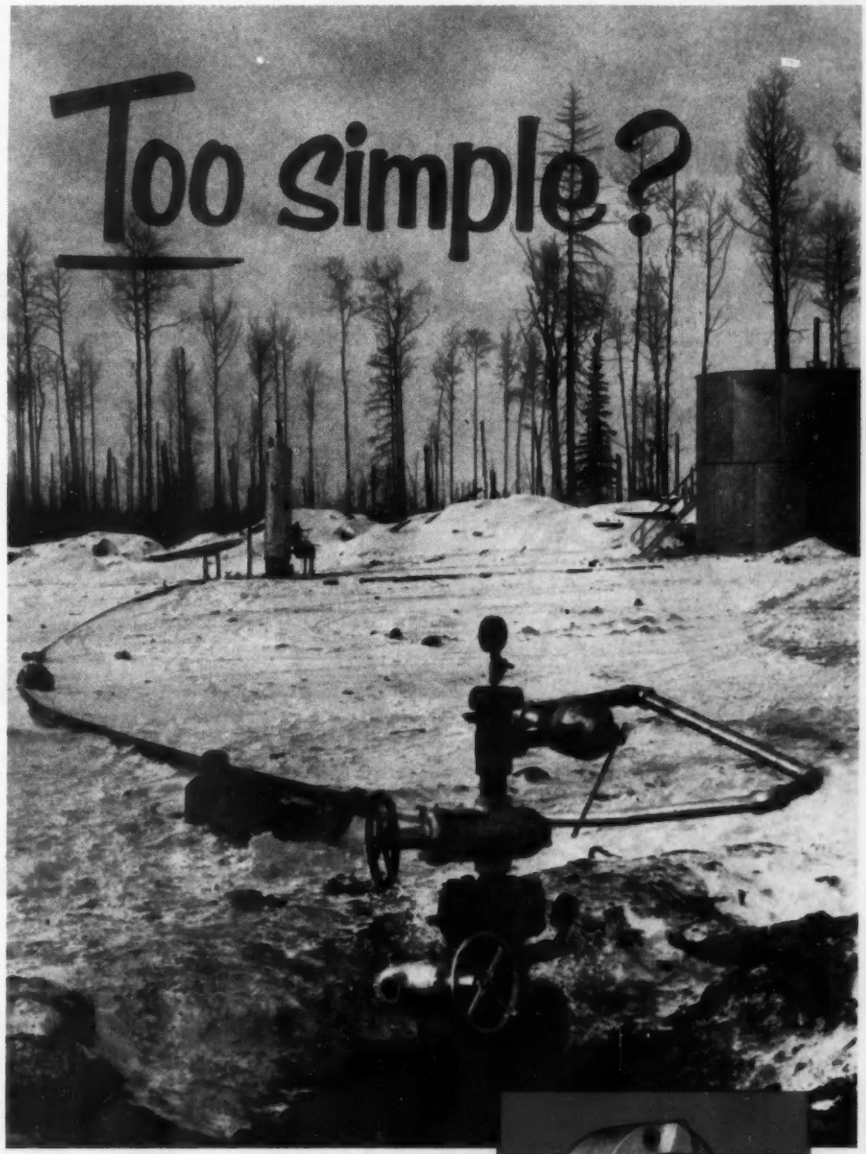
•

William F. Martin was appointed manager of manufacturing for pump products and oilfield products of the **Byron Jackson Division, Borg-Warner Corporation.** He has been associated with General Motors Corporation for the past 12 years as a production engineer and production manager. Immediately before joining Byron Jackson he was manufacturing manager of the Clinton Road Plant of General Motors' Euclid division (earth moving equipment) in Cleveland, Ohio.

W. F. Martin

Reginald G. Farrar

Reginald G. Farrar has been appointed manager of market research for **The National Supply Company.** The position is a newly-created one, in line with the company's product diversification and expansion program. Farrar's responsibilities will include market analysis, distribution analysis, and effective use of sales records and controls, both for the company's existing products and new products to be developed. Prior to this appointment, he was manager of market research for Oliver



In the northern frontier of Alberta, the two-valve, uncomplicated Christmas tree of the Union Oil Company well "Red Earth 12-17" loafs along at 200 BPD, reduced from a tested 960 BPD, through a

WILLIS
Rotary Adjustable Choke

Adjustable Flow Control with Pre-determined Accuracy

Willis Rotary Adjustable Choke provides 6 different size choke inserts which are individually positioned in the line of flow by a fractional turn of the orifice-carrying disc . . . while under constant flow and high pressure. Simplicity of this uncomplicated Christmas tree (note deletion of wing valve) is accomplished by using a blank orifice in one of the 6 positions of the Willis Rotary Choke. Also without closing the master valve shut-in of the well can be effected.

WILLIS OIL TOOL COMPANY
3440 PINE AVENUE, LONG BEACH, CALIFORNIA
Houston: P. O. Box 12164 Park Plaza Station;
Odessa: P. O. Box 412; New Orleans: 497 Walnut St.;
Canada: Precision Oilfield Service, Ltd., Edmonton, Alta.

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

The New Clark Model CFA

takes the belts out

of compressing

That's right! The new Clark CFA packaged compressor doesn't require belts, jackshafts, countershafts, bevel gears, helical gears or any other type of gear or step-down device to drive it because it's direct-driven. Compressor and engine operate at a modern 1000 R.P.M. . . . that means only a simple rubber block type of coupling is used between the compressor and engine. The foot-per-minute piston speed is less than on many large stationary compressors. That's assurance of long cylinder life.

Vibration is virtually non-existent in the CFA. The Clark Balanced/Opposed design eliminates unbalanced forces and vibration. It won't "travel or walk away", even if operated on a glass-smooth floor. You can set it and forget it. In the field there is no need for a dozen or more yards of concrete to hold it down . . . use just enough to level it, that's all!

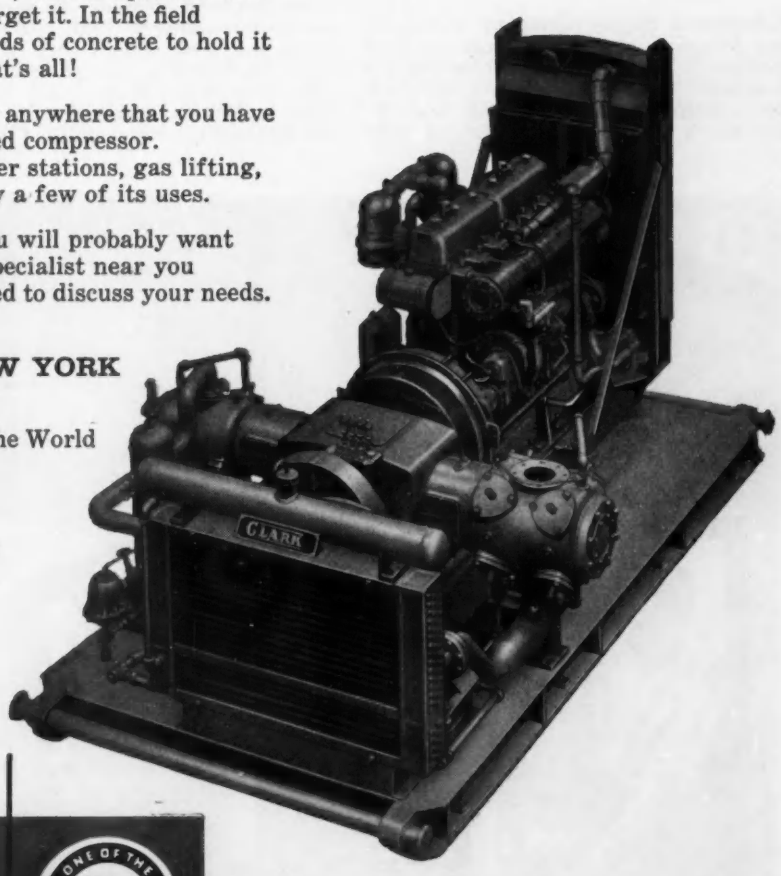
Where can the CFA be used? Practically anywhere that you have a need for a 75-200 horsepower packaged compressor. Boosting into gathering lines or to larger stations, gas lifting, pipeline testing and air drilling are only a few of its uses.

There are many added features that you will probably want to know about. There is a Clark CFA specialist near you who has all the facts and would be pleased to discuss your needs. Don't delay—call today.

CLARK BROS. CO., OLEAN, NEW YORK

One of the Dresser Industries

Offices in Principal Cities Throughout the World



Clark 175 BHP CFA-2 Balanced/Opposed Packaged Compressor station.

CLARK®

ONE OF THE DRESSER INDUSTRIES

Packaged Field Compressors

Iron and Steel Corporation. He did market research work for Westinghouse Electric Corporation from 1947 to 1954.

•

Durward Allen

Vaughn Holton

Fluid Packed Pump Company announced three promotions in the Sales department. **Durward Allen** is now district manager of the Abilene district, **Vaughn Holton** has been named assistant division manager for the Northwest division, and **Verlan Lewis** has been promoted to assistant division manager for the Gulf Coast division.

Verlan Lewis

•

Continental Supply Company announced the following changes in store manager personnel. **Henry C. Fox** will be the new manager for Continental's Shreveport store. **Ralph A. Broussard** will head the company's new outlet at Morgan City, La. **Forrest E. Amacker, Jr.**, will fill Broussard's former position as store manager at Harvey, La. Fox, an employe of the oil field supply company since 1951, has held positions of bookkeeper and floorman and previously was the division material man for East Texas, North Louisiana, Mississippi and Arkansas divisions. Broussard moves to his new position of heading Continental's newest supply store at Morgan City from Harvey, La. An employe of Continental for six years, his previous positions include field salesman and store manager at Houma, Louisiana. Amacker, former floorman and field salesman at Harvey, has been with Continental for five years.

•

Robert Graves Hess was elected executive vice president of the **Walworth Company**, manufacturer of valves and pipe fittings. Hess recently resigned as executive vice president of Pesco Products division, Borg-Warner Corporation. In his recent post, he was in charge of all activities of Pesco Products division including operations, engineering, accounting and sales. Prior to that time, he was general manager of The New York Air Brake Company, Watertown, New York; president and director of Kinney Manufacturing Company.

•

W-K-M Manufacturing Company, Incorporated, Houston, announced the election of **Robert O. Wynn** as vice president of manufacturing. Wynn came with W-K-M as chief engineer in 1951. After the company was made a subsidiary of ACF Industries, Incorporated, he was appointed general manager of the ACF Valve division in Detroit. He returned to W-K-M as director of manufacturing when ACF Valve division and the KEY Company of East St. Louis were consolidated with W-K-M.

•

H. G. Nelson, formerly field representative at Corpus Christi, Texas, has been promoted to store manager and field representative and transferred to Alice, Texas.

V. V. Dick has also received a promotion to store manager and field representative and has been transferred to El Dorado, Kansas. He was formerly field representative at Medicine Lodge, Kan.

•

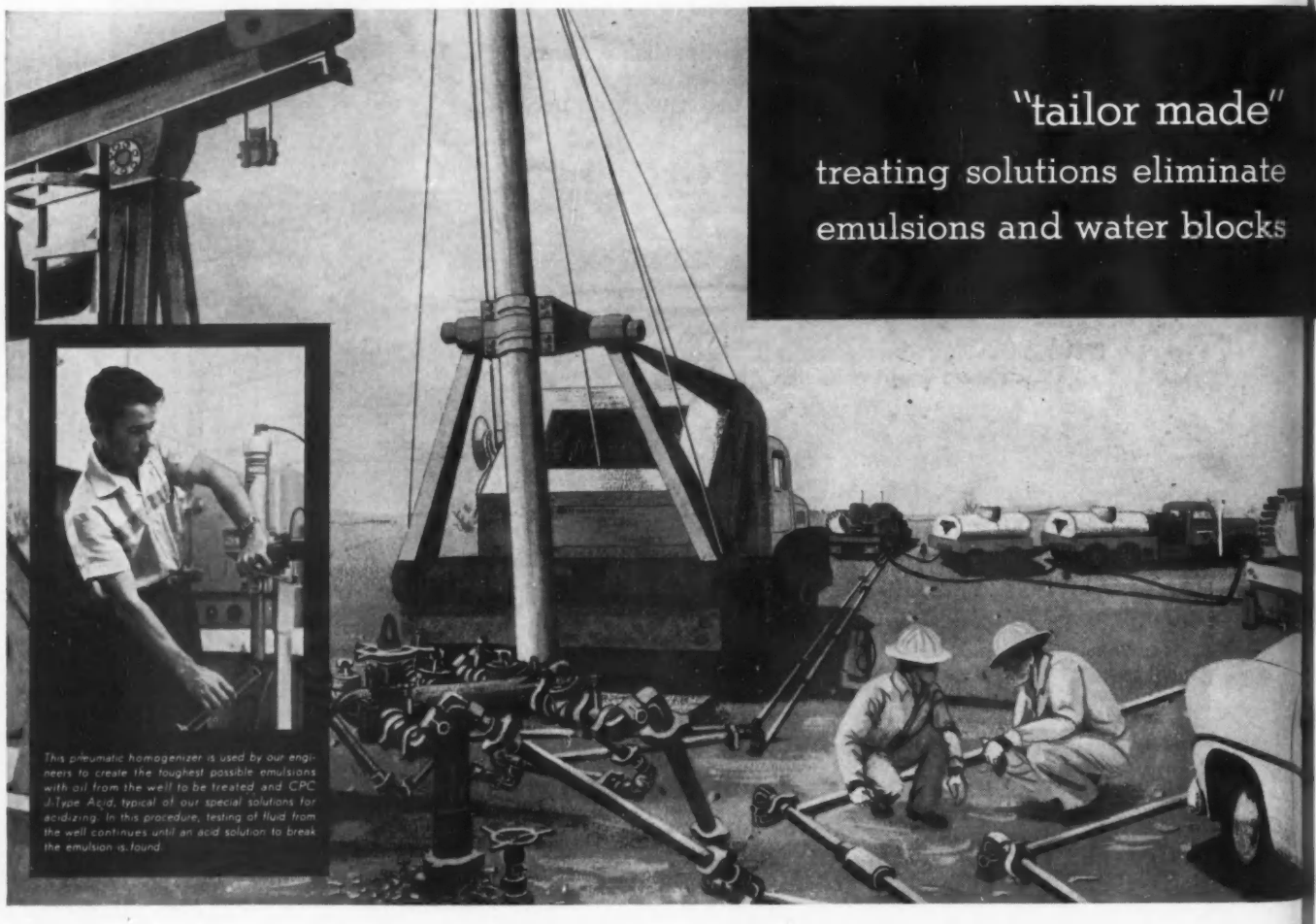
Warner Lewis, Jr., has been appointed head of **Warner Lewis Company's** newly opened Chicago zone office. The new office will supervise activities in Illinois, Ohio, Indiana, Wisconsin, Michigan and the eastern part of Missouri. The company is a division of the Fram Corporation.

•

Fluid Packed Pump Company announced the appointment of **Jack Gary** as the company's Latin American representative. Prior to his present assignment Gary spent the past two years in the Gulf Coast division of Fluid Packed Pump. In his new capacity he will make his headquarters at Maracaibo, Venezuela, working with National Supply Company on the distribution of Oilmaster products throughout Latin America.

•

Glenn M. Keeney has formed the **Keeney Well Servicing Company** with headquarters in Pleasanton, Texas. Keeney was formerly a partner in the Gaines Drilling Company of Corpus Christi, Texas.


"tailor made"
treating solutions eliminate
emulsions and water blocks
This pneumatic homogenizer is used by our engineers to create the toughest possible emulsions with oil from the well to be treated and CPC J-Type Acid, typical of our special solutions for acidizing. In this procedure, testing of fluid from the well continues until an acid solution to break the emulsion is found.

Otis Pressure Control, Inc., and its manufacturing affiliate, Otis Engineering Corporation, have announced realignment of personnel in the general offices and manufacturing plant in Dallas. **Lowell M. Wilhoit**, vice president of sales and service for Otis Pressure Control, has been appointed vice president in charge of engineering for Otis Engineering. **James E. McGinley**, former personnel director for Otis Engineering, was transferred to Otis Pressure Control as director of sales and service. **Kenneth W. Robbins**, formerly service manager, was named to a new position of director of export department sales and service. **Warner M. Kelly**, former division manager and chief caliper engineer for Otis in Houston, was transferred to Dallas to take Robbins' former position. **Carl M. Schwab**, former chief engineer for Otis Engineering, was transferred to Houston as division manager for Otis Pressure Control. **Harry M. Schramm**, former vice president in charge of engineering, was appointed vice president in charge of research and development for Otis Engineering. **Stanley Noska**, former general foreman of production, was appointed plant superintendent. **T. G. Garwood** continues as sales manager for Otis Pressure Control and **W. E. Rich** as vice president and treasurer of the two corporations.

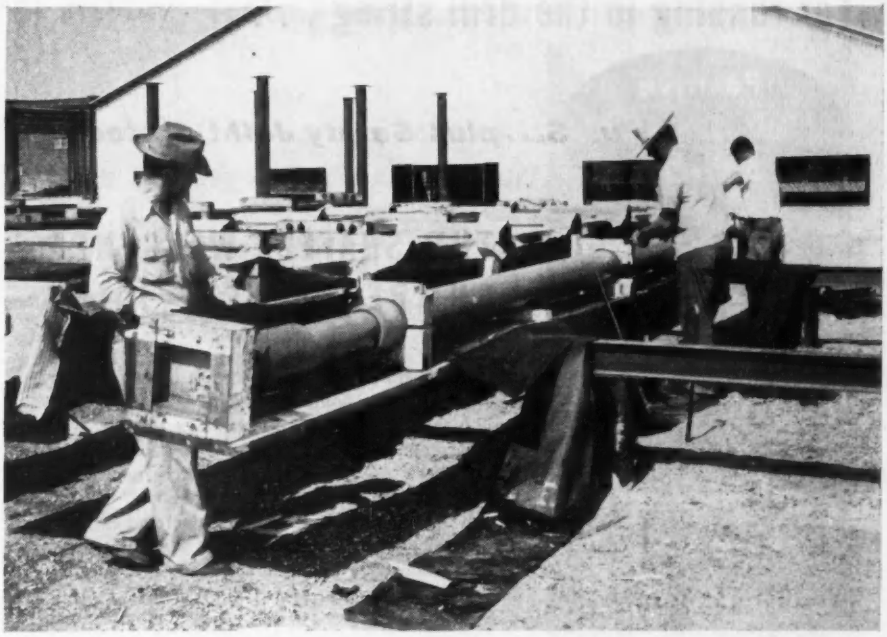
•

S. W. Fruehling has been named manager of the new **Seismograph Service Corporation's**, affiliate in Brazil.

•

Warren A. Logelin has been named director of public relations for **Crane Co.**, it was announced. He succeeds **Russell G. Creviston** who retired.

Before joining Crane, Logelin was director of public relations for the Chicago Association of Commerce and Industry, and previously had been director of advertising for the Chicago Transit Authority. He was named Crane's assistant director of public relations in 1955.



Russian Turbo Drills Delivered to Dresser

Here are some of the 40 turbo drill units just delivered to Dresser Industries in Dallas by Russia. Currently, a rig is being assembled in one of the Dresser yards where the turbo units will be subjected to actual drilling tests. From that point, the units may be taken to hard rock country where more exacting testing can be conducted under adverse conditions. The units imported are the type "T-12M-10."

William V. Rathbone, formerly executive vice president of Parkersburg Rig & Reel Company, has been named vice president in charge of sales for the **Delta Tank Manufacturing Company.**

CHEMICAL PROCESS COMPANY

J-TYPE ACID

▼ J-Type Acid is used to eliminate or minimize the unfavorable effects of emulsions or water blocks which often prevent optimum results from acidizing treatments. To prevent, or to break, these emulsions, special chemicals are needed to change the interfacial properties of the acid and/or acid residue, and the crude oil.

Although the base is regular inhibited HCl, J-Type isn't a routine, "stock" solution for acidizing. Instead, it is especially formulated to meet the requirements of individual treatments. J-Type is tailor-made by CPC engineers, using a special homogenizer to create the severest and toughest emulsions with which to test J-Type additives.

J-Type Acid will reduce clean-up time, save rig time, and your well will get on production faster. More important — efficient clean-up after acidizing will mean longer life for your well.

Ask your nearest CPC station to tell you more about J-Type Acid, or write to us in Breckenridge, Texas. We will be glad to send you complete details and illustrated literature without obligation.

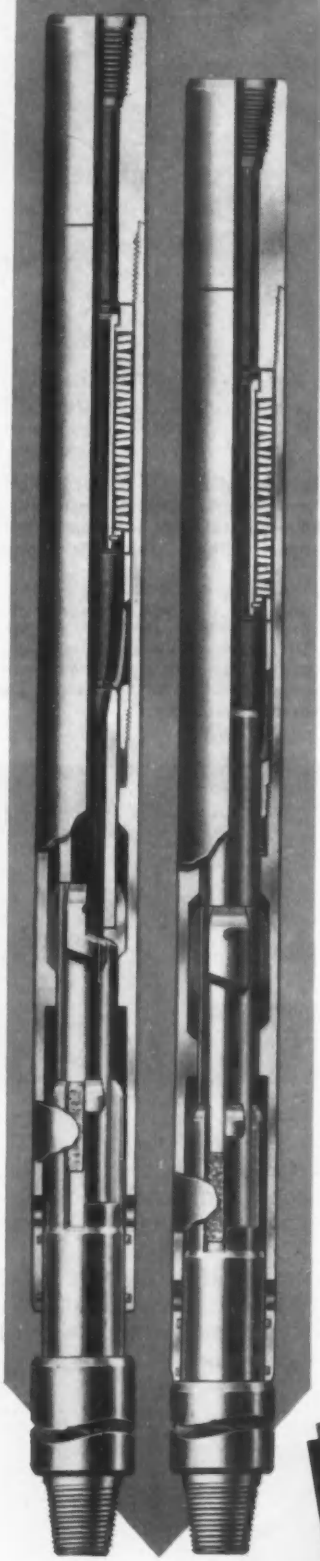
THE CHEMICAL PROCESS CO.
SERVICING OIL & GAS WELLS

THE CHEMICAL PROCESS COMPANY
General Offices and Laboratory in Breckenridge, Texas

For running in the drill string . . .

Positive JAR-DOWN ACTION

. . . plus Safety Joint protection!

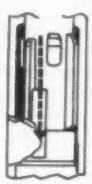


See the Shaffer section of your Composite Catalog.

THE SHAFFER-WAGGENER BUMPER SAFETY JOINT

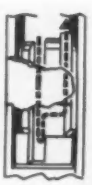
There is no other tool like the Shaffer-Waggener Bumper Safety Joint. It combines—in ONE tool—a choice of *jar-down* and *releasing* actions, both under complete control of the operator. What's more, the tool is so rugged it is run as part of the drill string to protect against stuck pipe.

In actual well service it has operated easily at depths below 18,000 feet, and has given no operating problems even in directionally-drilled wells with extreme slant.


Jar-Down Action

RUN IT IN THE DRILL STRING—It is specifically designed to withstand the continuous vibration and heavy torque loads of today's drilling operations.

TO JAR DOWN whenever the drill pipe threatens to stick—or to drive drill collars out of keyseats and to free "balled-up" bits—simply slack off weight equivalent to about 2,000 feet of drill pipe onto the tool. This releases the tripping mechanism, automatically striking a sharp down blow. Raising the string automatically re-sets the tool for another blow—and blows can be struck repeatedly as fast as the string can be raised and lowered. And no torque or twisting strains are placed in string!


Releasing Action

TO RELEASE, in the event jarring will not loosen the stuck string, simply trip the tool and apply reverse torque as the string is slowly raised. Only one-sixth turn of the tool rotates the drive keys into unlocking slots so that complete release is effected by continuing to raise the string.

ANOTHER ADVANTAGE—the tool transmits full torque loads in *either* direction through three rugged drive keys—not through easily-damaged threads. It is the strongest joint in the string—not the weakest, as with conventional safety joints.

Also, the tool can be re-connected again by simply lowering the top portion over the lower portion and reversing the releasing action. It is ideal for use in fishing strings!

Free 8 page bulletin gives the full story on the Shaffer-Waggener Bumper Safety Joint. Write for it—or ask your nearest Shaffer representative.

Under the agreement, mining companies and other firms desiring aerial geophysical survey or photogrammetric mapping service in Peru will be offered the combined facilities, equipment, and personnel of both Hycon and the government agency.

The Peruvian Agency will also act as Hycon's sales representative in that country. For the first time, firms operating in Peru will be able to contract for service with the Varian Nuclear Resonance Magnetometer. This instrument makes magnetic measurements which help to locate deposits of iron and other metal ores often associated with magnetic minerals.

Esso Gettysburg to Be Launched October 11 at Newport News, Va.

The Esso Gettysburg, a 37,800 deadweight ton supertanker, is scheduled for launching October 11 at Newport News Shipbuilding and Drydock Company yards at Newport News, Va. It is the first of four sister ships. Each will have a carrying capacity of 315,000 barrels and will be the biggest and fastest tankers yet built for U. S. flag operation.

The Esso Washington will be launched later in 1956 and the other two are slated for 1957 completion. The ships are being built in accord with the U. S. government's "trade-in-and-build" program. Five war-built Esso T-2's have been transferred to the reserve fleet in connection with this construction.

Bethlehem Steel to Build Largest Tanker for Niarchos

Stavros S. Niarchos has contracted with Bethlehem Steel Company for the construction at the company's Quincy, Mass., yard of a 65,000-ton supertanker, bigger than any built in this country to date. The ship will be built for Transoceanic Marine Inc., the New York agent of Niarchos group of shipping firms.

The ship will be 850 feet long and 115 feet wide (too wide for Panama Canal locks), and a loaded draft of 42 feet. Its capacity will exceed 550,000 barrels of oil. The supertanker will cost over $16 million. Fully loaded, it will displace tons and have a top speed of 17 knots. It will fly the U. S. flag.

Dresser Manufacturing to Build Plant for Compression Fittings

Dresser Manufacturing division, Bradford, Penn., one of the Dresser Industries, plans the construction of a new million-dollar plant in Wellsboro, Penn. The new plant will contain some 100,000 square feet of manufacturing space, and will employ between 200 and 300 persons.

Compression fittings will be manufactured at this new plant, which is scheduled for completion by early 1957.

U. S. Steel Opens New Stores At Liberal and Hill City, Kansas

Two new stores in Kansas to serve two of the state's key oil areas were opened by the Oil Well Supply division of U. S. Steel Corporation. The new Oilwell branch stores are located at Liberal and at Hill City.

Manager of the Liberal store is Russell R. Runyon, who has transferred from Oilwell's El Dorado, Kansas store where he held a similar post.

BJ Service Adds Trucks

Byron Jackson Service, Inc., has increased its fleet of trucks with the introduction of a new wire line shooting truck and a companion radioactive logging truck. The new shooting truck is equipped to carry 20,000 feet of cable and contains the latest instrumentation and covers all wire line services. The companion unit, the simultaneous radiation logging truck, is the most recent addition to BJ Service's R/A logging service. These trucks have been assigned to the Pacific Coast division.

Twin Disc Clutch Plant Dedicated at Racine

The Honorable Walter J. Kohler, Governor of Wisconsin, formally dedicated a new Twin Disc Clutch Company plant at Racine, Wis. At the same time, he gave recognition to P. H. Batten, chairman of the board, on the 38th anniversary of his founding of the company.

The first unit of this new Twin Disc plant will provide 92,500 square feet of additional floor space. The $2 million structure will be used for expanded production of models now turned out in the original Racine plant and at the Hydraulic division in Rockford, Ill.

Designed with an eye toward even further expansion in the future—the plant layout is such that the building can be expanded at least five times.

Location of the plant, on a 22-acre tract, is adjacent to the St. Paul railway tracks, thus providing excellent shipping and receiving facilities.

American Cyanamid's New Plant To Manufacture Textile Fiber

American Cyanamid Company will construct a plant near Pensacola, Fla., for production of a new acrylic textile fiber called Creslan. A new division, the Fibers division, will have responsibility for the selection and direction of the organization required in the production and marketing of the company's new fiber.

Alden R. Loosli has been appointed general manager of the new division. Other appointments in the Fibers division include W. L. Lyall, sales manager; C. W. Bendigo, technical director; and N. H. Marsh, who will be manager of the Florida plant.

Magcobar Constructs Plant For Their Venezuela Affiliate

Magcobar de Venezuela, C. A., a new Latin-American affiliate of the Magnet Cove Barium Corp., one of the Dresser Industries, has been organized in Puerto La Cruz, Venezuela. The new Venezuelan corporation will include mining, processing, and distributing facilities for the marketing of Magcobar's line of oilwell drilling mud additives. Already under construction is a processing plant in Puerto la Cruz, and another is projected for the Maracaibo region.

Heading up the company's activities as

For fishing, testing and core-drilling strings . . .

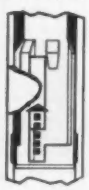
. . . plus Safety Joint protection!

Positive JAR-UP ACTION

THE SHAFFER OIL-SEALED JAR SAFETY JOINT

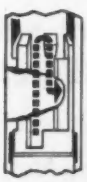
The Shaffer Oil-Sealed Jar Safety Joint is the only tool that combines a choice of *jar-up* and *releasing* actions, both under complete control of the operator at all times. What's more, all operating parts are sealed in a chamber filled with clean oil, fully protected against mud, sand and corrosive fluids.

The sealed-in-oil protection not only safeguards against abrasion and corrosion, and minimizes pressure differentials on packing elements, but also insures constant operating characteristics at all depths. This makes the tool ideal for fishing, testing and similar strings where light connections and equipment are used!



Jar-Up Action

▶ JARRING ACTION IS AUTOMATIC —simply raise the drill string until tension equals the pre-set tripping load, whereupon a sharp up blow is struck. Lowering the tool automatically re-sets the tripping mechanism for another blow—and repeated blows can be struck as fast as the string can be raised and lowered.



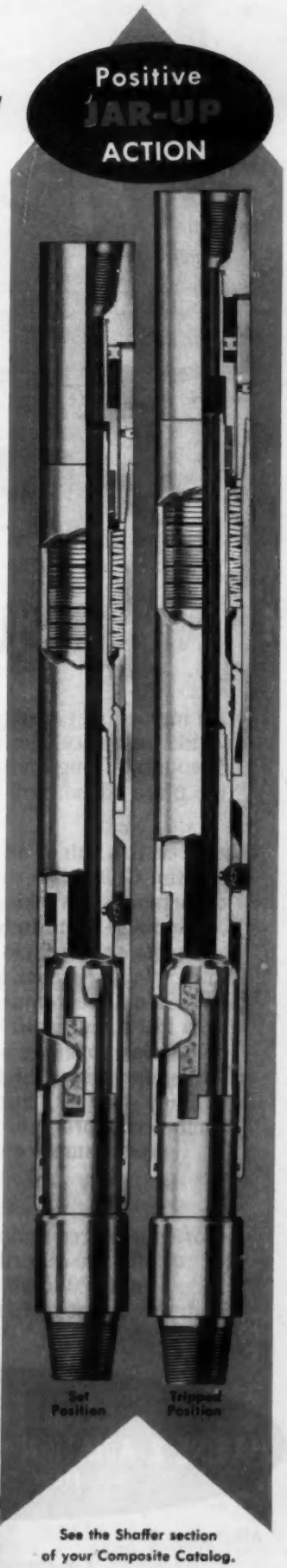
Releasing Action

▶ ONLY STRAIGHT PULL is necessary to operate the tool—no torque or other secondary operations to affect the light connections commonly used in fishing, testing and coring strings.

▶ TO RELEASE, in the event the fish or stuck string cannot be loosened, simply trip the tool and apply reverse torque as the string is slowly lowered. Only one-sixth turn of the drive keys rotates them into an unlocking slot whereupon raising the string allows the parts to unlock.

AND NOTE THIS—not only does the tool transmit full torque loads in *either* direction, but no threads are used in the releasing mechanism. Therefore there's no risk of torque over-tightening the tool—nor can reverse rotation accidentally release it.

Also, force of the blow is absorbed by integral knocker heads—not by easily damaged drive keys or threads. The tool is designed for *sustained* jarring operations. And since it does not depend upon friction for its tripping action, the Jar Safety Joint always operates with the same pre-set action. Light strings are not subjected to unpredictable loads!



Free 8 page booklet gives many other facts about the Shaffer Oil-Sealed Jar Safety Joint. Write for it—or ask your nearest Shaffer representative.

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

SHAFFER TOOL WORKS, Brea, California • California Service Shops: Santa Fe Springs and Taft
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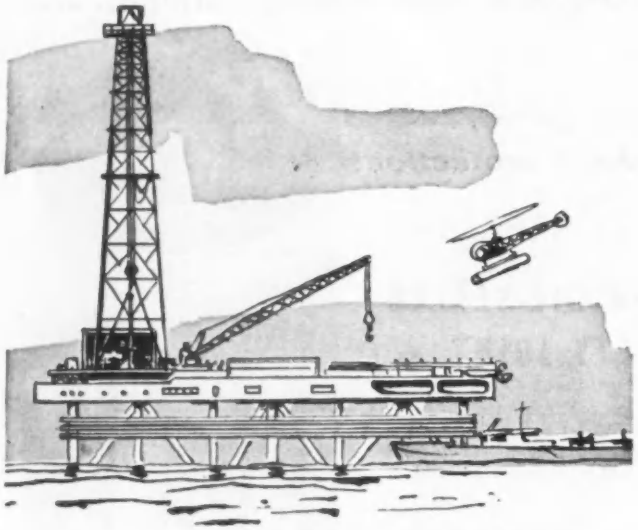
OKLAHOMA CITY, OKLAHOMA, Shaffer Tool Works, 6301 South Shields Boulevard
FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 546
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U. S. A.

33 years

See the Shaffer section of your Composite Catalog.



OFFSHORE OIL INSURANCE

An important phase of our business is to provide insurance agents and brokers with a sound, strong and experienced market to place offshore oil insurance coverage.

Located at the hub of offshore oil operations in the Gulf of Mexico, we have had the opportunity of working—almost since the beginning—hand in hand with insurance agents and brokers for the oil industry in developing proper insurance protection for this unique venture. We have learned a lot! As a result, we can now provide broad coverage specially adapted for offshore operations, high limits required by new-type structures, and an effective engineering program to hold down losses (and insurance costs) and eliminate down time.

For experienced and specialized handling of offshore oil drilling and production insurance in all its phases, ask your insurance agent or broker to talk with us.

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NEW ORLEANS

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KEEP PURE DRINKING WATER ALWAYS HANDY

insist on the highest quality

Gotkool
water cans and coolers

Specify **"GOTKOOL"** the next time you order water cans or coolers. **"GOTKOOL'S"** exclusive construction keeps water cooler . . . fresher . . . purer. Extra wide, snug-fitting, splash-proof top keeps out impurities. Non-leaking, push-button faucets, either extended or recessed flush-mounted. *Buy* **"GOTKOOL"** *at your supply store today.*

GOTKOOL Water Cooler — made in 1½-, 2-, 3-, 5-, 10-, 15-, and 20-gallon sizes with either extended or recessed, flush-mounted faucet. *Note:* 15- and 20-gallon sizes available with extended faucet only.

GOTKOOL Water Can — made in 1½-, 2-, 3-, 5-, 10-, 15-, and 20-gallon sizes without faucet.

Insist on the genuine — look for the *Blue and Black Label* with the name "GOTKOOL" in Red.

H. P. GOTT MFG. CO.
WINFIELD, KANSAS

Are you drilling a Wildcat Well?

PROVEN GEOPHYSICS

The New and Improved Amazing Attractometer

The latest and most modern method of geophysical exploration that shortens the route to petroleum reserves by rigid instrumental recordings, indicating the existence or not of hydrocarbon accumulations, and approximate depth. Ten locations for a major oil company without error. Surveys conducted for cash fee and chance to earn small override, oil payment, leases or other interest, where saturation is indicated in commercial quantities. Information on request.

To establish conclusive proof of the accuracy of our geophysical work, we will, without cost to you, test and record a log of your well on tape, bearing your signature and ours, of your rank wildcat location, in advance of drilling, indicating the existence or not of petroleum in commercial quantities underlying the tested areas and approximately at what depth it may be found. The instruments are entirely self-operating during testing period.

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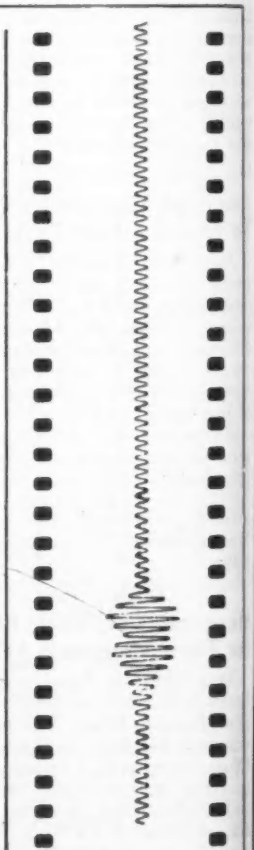

Specimen of log tape indicating saturation with break in zone

vice-president is Mario Sanchez. Willard Johnson of Houston, president of the Magnet Cove Barium Corporation, will also officiate as president of the South American company.

New Company to Be Known As Cresent Oil Well Supply

A. Rex Watkinson Jr., announced the formation of a new oil field equipment company to be known as the Crescent Oil Well Supply Company. Watkinson will be president and general manager of the company. The organization will have main offices in Tulsa and a sales outlet in Okemah, Okla.

A. R. Watkinson

George Coleman Jr., has been appointed store manager and sales representative for the Okemah store.

The Crescent Oil Well Supply Company will handle all types of oil field and rotary equipment.

$1.3 Million Settlement Paid By Avondale Marine Ways

One of the largest single insurance settlements in the deep south area was recently completed with full payment being made for the $1.3 million offshore oil barge-rig loss suffered recently by the Avondale Marine Ways, Inc., of New Orleans.

Thomas Q. Winkler, president of Winkler & Company, Inc., also of New Orleans, insurance brokers and agents that placed the risk, presented a check for $1,339,782 to J. H. Bull, Avondale's president, for the accidental loss to the newly constructed offshore oil barge-rig which was moored to the west bank of the Mississippi River at the Avondale plant across from New Orleans.

The record settlement was made within seven days after the accident had occurred on August 10, 1956. It was estimated that the depth of the Mississippi River where the rig capsized is some 90 feet deep.

The check was issued by the Marine Office of America.

The offshore drilling barge-rig was constructed by Avondale for both the Southeastern Drilling Corp., Dallas, and The California Company of New Orleans. The drilling unit, a self-contained, diesel-powered S-45 type, was destined to be taken to a 25-foot depth or more location in the Gulf of Mexico. Instead of being the conventional type of four-legged derrick, the barge-rig was equipped with a jack knife derrick. It was to have been towed into its new position in the Gulf of Mexico two days after the accident occurred.

Jones & Laughlin Locates Near Morgan City, La.

The opening of a new oilfield supply store in the Louisiana Gulf Coast sales district of Jones & Laughlin Supply Division, headquartered in Tulsa, is announced. The newly-constructed store, located on highway 90 approximately a mile east of the city limits of Morgan City, La., was opened for business the latter part of August. The sectional steel

See Joe Roughneck at the API — Room 544A Conrad Hilton Hotel

"thinks a 'round trip' means traveling"

The oil industry continues to go places at a faster and faster pace . . . and, in turn, Lone Star Steel has announced extensive plans to make more and more pipe.

API casing, tubing and line pipe, from Lone Star, is standard of the industry in the great mid-continent oil area . . . where Joe Roughneck is busy day and night . . . drilling for oil to supply the ever-increasing demand.

Lone Star's recently announced plans for another open hearth furnace and more pipe mill facilities have one objective . . . to serve Joe Roughneck better and faster.

Neighbor, wherever you are, specify Lone Star and we both get a good deal!

Lone Star STEEL COMPANY

LSS

EXECUTIVE-SALES OFFICES
W. Mockingbird Lane at Roper • P. O. Box 12226 • Dallas, Texas

DISTRICT SALES OFFICES
Houston, Texas | Midland, Texas | San Antonio, Texas
Tulsa, Oklahoma | Wichita Falls, Texas | Shreveport, La.

structure houses two offices at the front and a warehouse at the rear.

B. E. Trisler, formerly manager of the firm's Lake Charles, La., store, has been appointed local manager of the Morgan City store; and Loran W. Todd, formerly at Houma, La., has been assigned to the new location as sales representative. Assisting Trisler in store operations are: G. E. Bender, W. L. Herrington, G. R. Robinson and P. T. Huddleston.

The Morgan City store, which becomes the sixth store point in J&L Supply's Louisiana Gulf Coast district, will be under the over-all supervision of Clarence E. Rogers, district sales manager headquartered in New Orleans.

5 reasons why ELGEN provides the best electronic well logging service available

1. New and improved equipment!
2. A highly qualified research staff!
3. Advanced interpretation techniques!
4. Fast, on-the-well service when you need it!
5. Skilled and long experienced field engineers!

ELGEN gives you accuracy, sound interpretation, lower price schedules, minimum rig time. Join the operators who are turning to ELGEN for the most satisfactory logging service to be found.

DIVISION OFFICES AND SERVICE LOCATIONS

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Ballinger, 710 Strong Ave., Tel. 2-1062
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Oklahoma City, 509 Cravens Bldg., Tel. RE 6-3669
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Duncan, 219 Ritz Bldg., Tel. 3490
Fort Morgan, Colo., 218 Ensign St., Tel. UN 7-7163
Graham, 100 Elm St., Tel. 1000
Gainesville, 423 Cuiberson St., Tel. HO 5-2322
Tyler, 211 North Hill St., Tel. 2-2430
Tulsa, 219 Oil Capital Bldg., Tel. GI 7-7610
Ponca City, 208 S. Second St., Tel. RO 2-1796
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Atkinson to Build Drilling Island For Richfield Oil Corporation

Richfield Oil Corporation has awarded a contract to the Guy F. Atkinson Company of San Francisco and Long Beach for construction of a drilling island on its 1175 acre State tideland lease offshore from Rincon, approximately nine miles west of Ventura, Calif.

The island will consist of an outer ring of breakwater rock with a land filled center. It will be built in 45 feet of water approximately 3000 feet southwest of Punta Gorda. Total area of the man-made structure will be about three acres at the water line. Net working area will be slightly more than one acre. A small boat dock will be constructed on the east side to accommodate craft carrying crews and supplies.

Youngstown Sheet and Tube To Expand Building Facilities

The Youngstown Sheet and Tube Company will build a modern, new three-story general office building. It will be constructed on a 52-acre plot just south of Boardman Center on Market Street and will be ready for occupancy around late 1957. The building will be completely air-conditioned and have a total floor area of approximately 183,000 square feet.

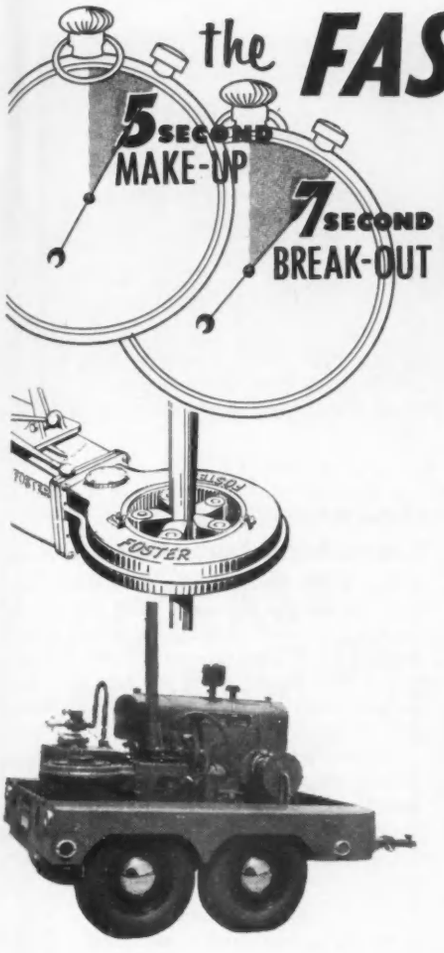
J. L. Mauthe, president, indicated that present office facilities in the Stambaugh building had become inadequate for the Company's growing employe force. He said that the new building would provide ample space for future expansion. Construction will start as soon as the ground can be cleared.

H. K. Porter to Combine West Virginia and Connors

H. K. Porter Company, Inc., is acquiring, as of October 1, the business of West Virginia Steel and Manufacturing Company, Huntington, W. Va. The new plant will be combined with Porter's Connors Steel division of Birmingham, Ala. Sales of the newly acquired concern are currently at the rate of $18 million annually.

J. J. Durkin, West Virginia's executive vice president, will continue to supervise operations at Huntington.

West Virginia Steel melts and rolls electric furnace steel and rails. Its products include light steel rails, reinforcing bars, mine roof bolts, hot rolled bars and semi-finished steel. Porter plans to expand the West Virginia operation.



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U. S. Army Ordnance Corps To Get Research Institute

A new laboratory for research on fuels and lubricants of the future, first of its kind in the country, will be built for the U. S. Army Ordnance Corps at Southwest Research Institute, San Antonio, it was announced. Ground-breaking for the new laboratory, which will cost approximately $3¼ million, was held July 18.

Upon completion the laboratory will be staffed and managed by Southwest Research engineers and technicians, who will have the responsibility of developing and testing fuels and lubricants adequate to meet the needs of new types of weapons and other Ordnance equipment, many of which are still on drawing boards. Southwest Research Institute has offered facilities for scientific and industrial research groups interested in locating at the center, providing a pool of manpower and facilities.

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Miller & Chitty to Sell Cleaver-Brooks Equipment

The Cleaver-Brooks Company announced the appointment of the Miller & Chitty Company as manufacturers' representative for the sale of Cleaver-Brooks boilers and equipment. Its territory will include counties in northern New Jersey and Staten Island.

Cleaver-Brooks manufactures equipment for the generation and utilization of heat. Among its products are oil, gas and combination oil/gas fired stationary boilers, mobile steam boilers, distillation equipment, evaporators and industrial oil and gas burners.

J. A. Grundy

H. B. Book

Reed Promotes Book, Elliott, Grundy to Vice Presidencies

Reed Roller Bit Company has announced the promotion of three men to vice presidencies. For the Oil Tool division, **H. B. Book**, former export sales division manager, was named vice president, sales, and **J. A. Grundy**, former factory manager, was named vice president, manufacturing. **C. H. Elliott**, former manager of the Cleco Air Tool division, was named vice president of that division. Book has been with the Oil Tool division in both domestic and foreign sales work since 1928. Grundy has been with Reed since 1937 and Elliott came to Reed in 1940.

C. H. Elliott

Schramm, Inc. Expands Factory

Using a Pneumatractor with Schramm Backhoe, Henry N. Schramm, president, breaks ground for a one story building 600 feet by 60 feet, which will increase the factory floor space from 145,000 to 181,000 square feet. The witnesses are Lewis Michener, plant engineer; S. E. Smith, treasurer; and Edward W. Wilson, factory manager.

Guiberson Corporation Added To Dresser Industries

Dresser Industries, Inc., has completed negotiations for the acquisition of the assets of the Guiberson Corporation of Dallas. The reported consideration is said to be approximately 110,000 shares of Dresser common stock.

Guiberson is a manufacturer of specialized oil well production and drilling equipment such as tubing and casing swabs, molded rubber products, and other products. The Guiberson product line will round out and supplement the equipment and services rendered by the other Dresser companies.

No change in personnel or general policies is contemplated. Gordon Guiberson has agreed to become a member of Dresser's board of directors and will remain as president of Guiberson.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, and JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF WORLD OIL, published monthly at Houston, Texas, for October, 1956.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher Ray L. Dudley, 3371 Chevy Chase, Houston, Texas; Editorial Director, Warren L. Baker, 5324 Cherokee, Houston, Texas; Managing Editor, Wallace Fitzgerald, 1514 Hewitt Drive, Houston, Texas; Business Manager and Executive Vice President, Tom W. Nelson, 3071 Locke Lane, Houston, Texas.

2. The owner is: The Gulf Publishing Company, Houston, Texas; James Anderson, Houston, Texas; June Wooden Dudley Bliss—Trustee, Houston, Texas; A. L. Burns, Houston, Texas; Grace C. Carter, Dallas, Texas; Margaret D. Cashman, Houston, Texas; P. Stinson Dudley, Eldorado, Texas; Ray L. Dudley, Houston, Texas; William G. Dudley, Houston, Texas; William V. Gross, Alpine, Texas; Carolyn Dodson Keeble, Abilene, Texas; Anita S. Lane, Houston, Texas; Charles H. Lane, Houston, Texas; L. J. Logan, Houston, Texas; James W. Nelson, Baytown, Texas; Tom W. Nelson, Houston, Texas; Walter Gage Sterling—Trustee, Houston, Texas; O. R. Waller, Chicago, Illinois.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: NONE.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)

RAY L. DUDLEY
Publisher

Sworn to and subscribed before me this 25th day of September, 1956.

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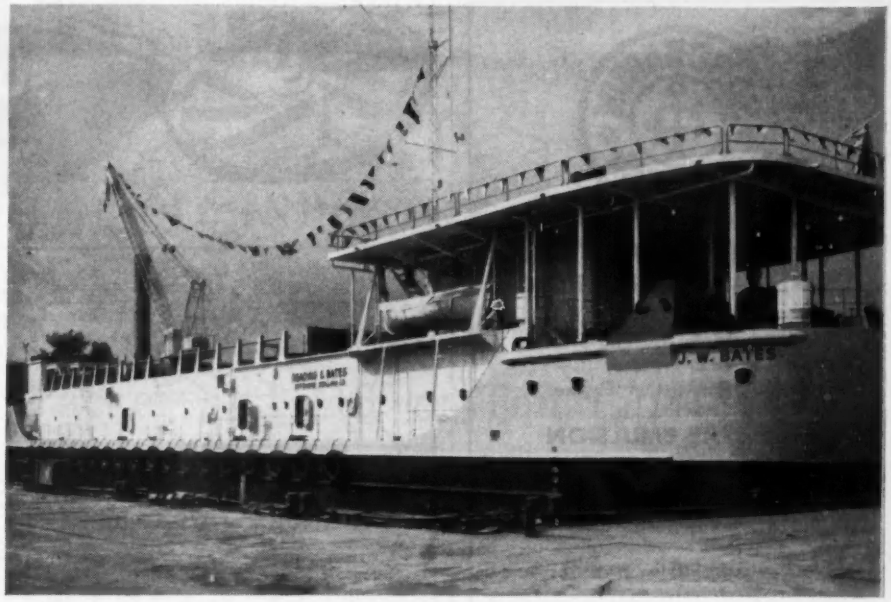

Offshore drilling tender J. W. Bates built by Levingston Shipbuilding Company for Reading & Bates Offshore Drilling Company of Tulsa.

Levingston Company Completes Innovation in Offshore Drilling

Levingston Shipbuilding Company of Orange, Texas, has recently completed what is believed to be a new concept in offshore drilling equipment for the Reading & Bates Offshore Drilling Company of Tulsa, Okla. The compact unitized drilling rig will work in conjunction with the Drilling Tender. This drilling unit is 64 feet long, 40 feet wide and 30 feet high, less the derrick and weighs approximately 300 tons.

The unit will be placed on a permanent platform on pilings driven into the ocean floor at the well site and the drilling tender will be anchored along side. The drilling unit consists of the following equipment: mud pump, rotary, drawworks, circulating pump, air compressor, generator, Schlumberger Unit, water tank, fuel tank, air receiver, two shale shakers, one mud D-Gasser and one light plant. It is a packaged unit which can be divided into two sections for shipping and handling. The front section weighs 123 tons and the rear section 175 tons.

While it is being moved out to the well site, large cranes lift each section and place it on the barge with the other section placed beside it. Upon arriving at location the cranes lift and place each section on the permanent drilling platform.

The drilling unit will be removed from the platform when drilling operations at the well site have been completed and then be moved to another location in a similar manner by barge.

Security Rock Bits of England Is Producing U. S. Drilling Bits

Security Rock Bits, Ltd., Manchester, England, has begun full-scale production of the drilling bits developed in the U. S. by Security Engineering, Dallas, one of the Dresser Industries. The British company—control of which was purchased by Dresser Industries in January of this year, has been extensively retooled and is now supplying Security bits to the world markets. Previously, the company was known as Edeco, and manufactured rock bits under that trade name.

Jim Marshall Sales Named Cleaver-Brooks Representative

The Cleaver-Brooks Company announces the appointment of Jim Marshall Sales Engineering Service as manufacturers' representative for the sale of Cleaver-Brooks boilers and equipment.

Located at 135 West Hollywood, San Antonio, Texas, their territory will include counties in southern Texas.

Cleaver-Brooks manufactures equipment for the generation and utilization of heat. Among its products are oil, gas and combination oil/gas fired stationary boilers, mobile steam boilers, distillation equipment, evaporators and industrial oil and gas burners.

Walworth to Acquire Stock Of Grove Valve, Grove Controls

Walworth Company, a leading manufacturer of valves and fittings, has contracted to acquire all the outstanding capital stock of the Grove Valve and Regulator Company, and Grove Controls, Inc., both of Oakland, Calif.

The Grove companies have been leaders in new designs and developments in controls and ultra-high pressure regulators for the gas and oil producing business, and the chemical and petrochemical industries. Government agencies and their prime contractors also are among the principal markets for Grove control devices.

Schlumberger Moves Rocky Mountain Division

Schlumberger Well Surveying Corporation has moved its Northern Rocky Mountain division office from Casper, Wyo. to Billings, Mont. It is now permanently located at 411 Medical Arts building.

The staff in the Northern Rocky Mountain division office consists of J. L. Heath, division manager; W. W. Bilburn, staff assistant; C. R. Hazelbush, computer; and J. E. Skau, general field clerk. Schlumberger's Casper district office remains in Casper at 2400 East Yellowstone Ave., Robert E. Jones is the district manager.

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All Units complete with dog houses, light plants, tools, lines and ready to work. Excellent Condition. Location Southern Oklahoma. Write Box 4447, Oklahoma City.

■ ELI Drill M6D-160D on 1953 Ford F750. Combination air and 4½ x 5 GD Pump. Excellent Condition. $10,000.
ELI Ftill M6T5-209 on 1952, 2½ Ton Dodge. 6 x 6 Wheatley Pump. Excellent Condition. $7,500.
Drills may be seen at 61st Street and Elwood, Tulsa, Oklahoma.
SeisDrill, Inc., 515 Thompson Bldg., Tulsa, Oklahoma.

SITUATIONS WANTED

■ Exploration Geophysicist Available for Special Assignments. 25 years varied foreign and domestic experience. Leaving top geophysical post in large oil company at age 50 to devote time to independent interests. Would consider short term special assignments any part of world. Available January 1, 1957. Box 113-W, World Oil.

HELP WANTED

■ Well established, progressive oil field equipment manufacturer has openings for Sales Engineers. State qualification and references in first reply. Reply held in strict confidence. Box 114-W, World Oil.

RESEARCH CHEMIST
B.A. Degree from accredited school. Some graduate work preferred. Wide experience in hydrocarbon analysis. Interested in catalyst tests and development. Expanding new company. Start $600 per month.
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Due to our steady growth as a seismograph contractor with extensive inland as well as offshore operations we need Seismologists, Junior Seismologists, Chief Computers, Observers and Junior Observers. This is your chance to grow with a well established, progressive company. Salary commensurate with experience and ability. Contact:
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5115 Westheimer, Houston, Texas
P. O. Box 1129, Oil Center Sta., Lafayette, La.
5150 Desire, New Orleans, La.

WANTED

■ AIME transactions from the year 1945. If necessary, will buy complete set, new or used. Please contact either Mr. Osborne or Mr. Casey, Nortex Oil & Gas Corp., Life of America Building, Dallas, Texas.

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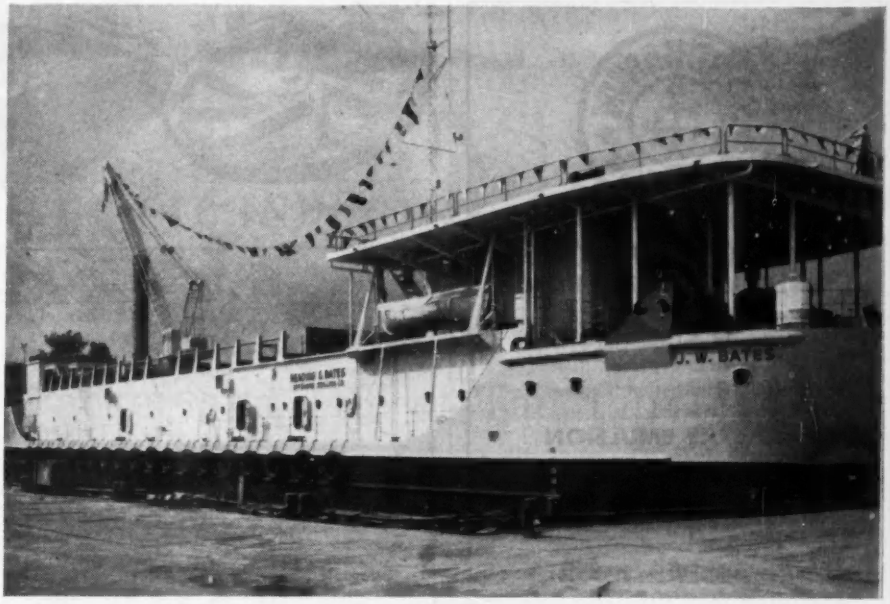

Offshore drilling tender J. W. Bates built by Levingston Shipbuilding Company for Reading & Bates Offshore Drilling Company of Tulsa.

Levingston Company Completes Innovation in Offshore Drilling

Levingston Shipbuilding Company of Orange, Texas, has recently completed what is believed to be a new concept in offshore drilling equipment for the Reading & Bates Offshore Drilling Company of Tulsa, Okla. The compact unitized drilling rig will work in conjunction with the Drilling Tender. This drilling unit is 64 feet long, 40 feet wide and 30 feet high, less the derrick and weighs approximately 300 tons.

The unit will be placed on a permanent platform on pilings driven into the ocean floor at the well site and the drilling tender will be anchored along side. The drilling unit consists of the following equipment: mud pump, rotary, drawworks, circulating pump, air compressor, generator, Schlumberger Unit, water tank, fuel tank, air receiver, two shale shakers, one mud D-Gasser and one light plant. It is a packaged unit which can be divided into two sections for shipping and handling. The front section weighs 123 tons and the rear section 175 tons.

While it is being moved out to the well site, large cranes lift each section and place it on the barge with the other section placed beside it. Upon arriving at location the cranes lift and place each section on the permanent drilling platform.

The drilling unit will be removed from the platform when drilling operations at the well site have been completed and then be moved to another location in a similar manner by barge.

Security Rock Bits of England Is Producing U. S. Drilling Bits

Security Rock Bits, Ltd., Manchester, England, has begun full-scale production of the drilling bits developed in the U. S. by Security Engineering, Dallas, one of the Dresser Industries. The British company—control of which was purchased by Dresser Industries in January of this year, has been extensively retooled and is now supplying Security bits to the world markets. Previously, the company was known as Edeco, and manufactured rock bits under that trade name.

Jim Marshall Sales Named Cleaver-Brooks Representative

The Cleaver-Brooks Company announces the appointment of Jim Marshall Sales Engineering Service as manufacturers' representative for the sale of Cleaver-Brooks boilers and equipment.

Located at 135 West Hollywood, San Antonio, Texas, their territory will include counties in southern Texas.

Cleaver-Brooks manufactures equipment for the generation and utilization of heat. Among its products are oil, gas and combination oil/gas fired stationary boilers, mobile steam boilers, distillation equipment, evaporators and industrial oil and gas burners.

Walworth to Acquire Stock Of Grove Valve, Grove Controls

Walworth Company, a leading manufacturer of valves and fittings, has contracted to acquire all the outstanding capital stock of the Grove Valve and Regulator Company, and Grove Controls, Inc., both of Oakland, Calif.

The Grove companies have been leaders in new designs and developments in controls and ultra-high pressure regulators for the gas and oil producing business, and the chemical and petrochemical industries. Government agencies and their prime contractors also are among the principal markets for Grove control devices.

Schlumberger Moves Rocky Mountain Division

Schlumberger Well Surveying Corporation has moved its Northern Rocky Mountain division office from Casper, Wyo. to Billings, Mont. It is now permanently located at 411 Medical Arts building.

The staff in the Northern Rocky Mountain division office consists of J. L. Heath, division manager; W. W. Bilburn, staff assistant; C. R. Hazelbush, computer; and J. E. Skau, general field clerk. Schlumberger's Casper district office remains in Casper at 2400 East Yellowstone Ave., Robert E. Jones is the district manager.

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Cut your installation costs, save time and make certain that rigs are safely guyed with Chance Screw Anchors. Tough, all-steel construction stands up in rough use and reuse. Screws into the ground in a hurry. Can be easily removed when the job is done or left intact for future use. Holds up to 11,000 pounds in average soil.

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"So they listened to me and leased thousands of acres with all those drilling obligations."

Background Music

Preacher: "And when I get through with my sermon I'll ask those of the congregation who want to contribute $5 toward the mortgage on the church to stand up. In the meantime you play appropriate music."

Organist: "What do you mean, appropriate music?"

Preacher: "You play the "Star Spangled Banner."

Home

Police Sergeant: "What, you back again?"

Drunk: "Uh, huh, any mail?"

Definitions

"Daddy, what does it mean that Mr. Smith went to the convention as a delegate-at-large?"

"It means he didn't take Mrs. Smith."

Book-of-the-Month

For book lovers only: "He beat her in the wigwam," or "Her sufferings were intents."

Nothing Like a Trip!

The rich old maid had a pet mama cat which she never let out of the house at night. Then she went on a cruise and her maid, left at home, received this cable: "Wonderful time, met swell man. Be sure to let the cat out of the house tonight without fail."

Just Plain Homely

A bad outbreak of horse and cattle rustling and stock stealing in general was taking place in the Ozarks. The communities were alerted and young men deputized to add to the normal police force. No sooner was all this organized than the national prize-winning hog was stolen.

As the thieves drove up to a road block, they put a hat and coat on the stolen hog in the car. Two new deputy sheriffs looked in the car, pointed to the driver and inquired, "What's your name?"

"Jack Haley," said the driver.

"What's yours?" the deputy asked the second man.

"I'm Jim Haley, Jack's brother."

Pointing to the hog, the deputy demanded, "And what's yours?"

"Oink," said the hog.

So the deputies searched the car and trunk, found nothing, and waved the driver on.

In a few seconds one of the deputies burst out laughing.

"What's so funny?" asked the other.

"Ain't that Oink Haley a homely son-of-a-gun?"

Precaution

"What will it cost to vaccinate me where it won't show?" she asked.

"My fee for that is ten dollars," said the young medic. "And I want it in advance."

"That much? That's terrible, and why in advance?"

"Because where I'm going to vaccinate you, I may just weaken and not charge anything."

Naughty Bunny!

"Whoever taught you that dreadful word?" Johnny's mother asked.

"The Easter Bunny," he answered righteously.

"The Easter Bunny!" his mother exclaimed.

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Service® *Anywhere Anytime*

New Services • • • New Tools • • • New Methods • • • Outstanding Results

Magna-Tector and Jet Casing Cutter Recover Pipe from 2880' in Only One Hour

This Kansas wildcat was being abandoned. The operator wanted to recover as much of his 7" O.D. 24 lb. N-80 casing as possible. He expected to get approximately 1500 feet.

McCullough's Magna-Tector located the lowest free point at 2880 feet. A McCullough Jet Casing Cutter made a cut at that depth and casing was removed from the well—1380 feet more that had been expected.

Locating the lowest free point and jet cutting the 7" casing required only one hour rig time. The operator was well pleased with the speed of the job and more than satisfied with the amount of casing recovered.

Magna-Tector Saves Washing Over Packer and 116' of Tail Pipe

Efficiency of McCullough Magna-Tector (Free Point Finder) and Chemical Tubing Cutter Saves Many Hours of Hazardous Fishing Operations

Operator of this California well could not pull his 2½" tubing and felt that the packer was stuck at 3793 feet.

Anticipating a tough fishing job, wash pipe was ordered to the well to wash over the packer and 175 feet of 2" E.U.E. tubing used as a tail pipe. At the same time McCullough was requested to make a chemical cut in the 2½" tubing just above the packer

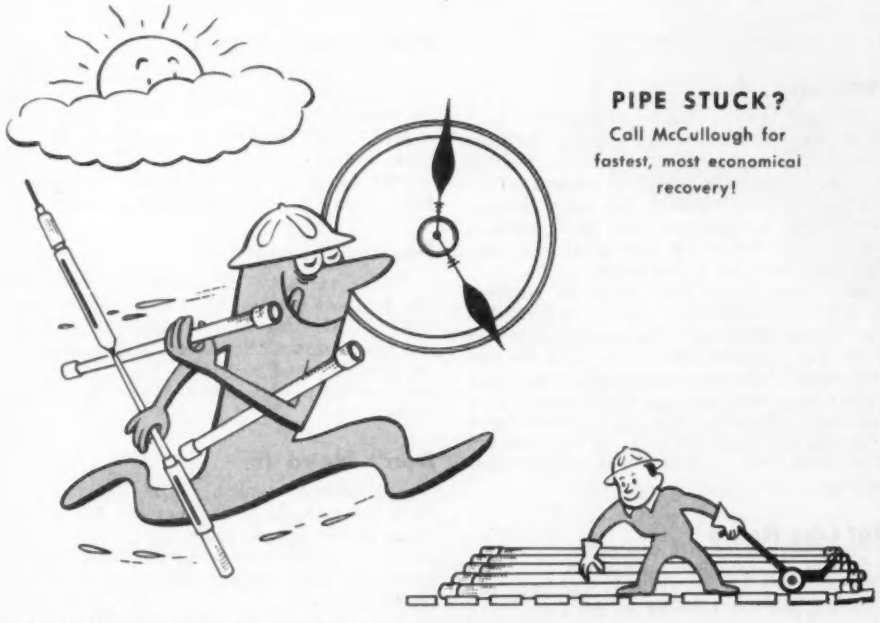
After thoroughly discussing the job, the operator decided to run McCullough's Magna-Tector, as the tubing could possibly be stuck below the packer.

The Magna-Tector located the lowest free point 116 feet below the packer in the 2" tail pipe. A 1¾" McCullough Chemical Tubing Cutter was run to the free point and the cut was made. Only 59 feet of 2" tail pipe was left in the hole to wash over and fish out

Four hours operating time were all that were required to locate the lowest free point and make the chemical cut.

This operator's foresight in making a check run with the Magna-Tector to be positive of the lowest free point, saved him many hours of rig time and hazardous washing over and fishing operations.

It was a fast job with better results than first expected. Needless to say—the operator was well satisfied.



The McCullough Magna-Tector (Free Point Finder) is the key tool in stuck pipe recovery. It accurately locates the lowest free point in stuck drill pipe, tubing or casing . in a hurry! Guesswork is eliminated.

Ideal companion tools of the McCullough Magna-Tector include the McCullough String Shot Back-Off, McCullough Jet Casing and Jet Drill Pipe Cutters and the famous McCullough Chemical Tubing Cutter. Write for full information—McCullough Tool Company, 5820 South Alameda Street, Los Angeles 58, California.

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SERVICE, INCLUDING
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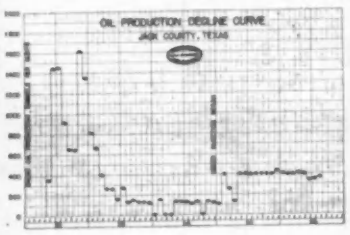
PRESSURE MAINTENANCE WITH GAS OR WATER

OIL PRODUCTION GRAPH

Pressure Maintenance with Water Injection



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. . . . without breakage!

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A powerful blend of quick-acting solvents that frees "frozen" parts without breakage. Safe for all metals and alloys.

Makes joints LEAKPROOF!

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Makes all assemblies leakproof and pressure-tight. Easy to apply with brush-in-handle.

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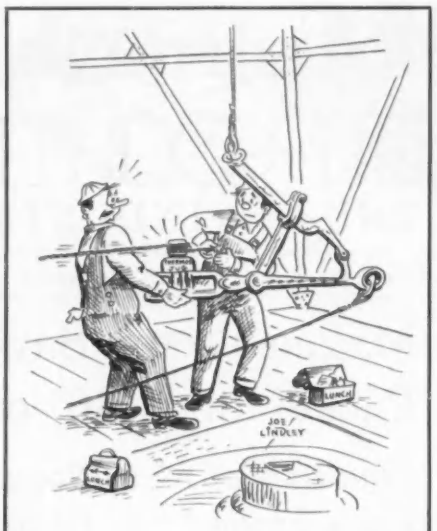


"Same thing every day. Why'd you marry a lady wrestler, anyway?"

"Yes, Mama," he answered, "when he fell over the chair in my bedroom on his way downstairs with the eggs."

Chip Off the Ole Block

A youthful mountaineer was brought into court and sentenced for breach of the peace. He had been feuding and had knifed his adversary. After the trial his grizzled old father stood with a group of his cronies on the courthouse lawn. "I swear," he said, "I don't see whar that boy gits his meanness. Now you take me, I never stuck a knife that deep in nobody."

Some Surprise

An East Texas farmer brought a load of produce to Dallas and during the day sold it at a good price. He then decided to surprise his wife who was always scolding him for wearing such old, worn clothes. He bought a complete new outfit, stowed the package under the seat of his car, and took time out for a few beers.

Half way home that night he stopped on a bridge, pulled off all his old clothes and threw them over the railing into the river, and reached under the seat for the new ones. They were not there; some thief had taken them during the farmer's beer interlude. Thoughtfully he climbed back into the car and stepped on the starter. "Oh, well," he mused, "I'll surprise her anyway."

Not Like Home

It was a very tense scene in the film. The audience sat enthralled. Suddenly the hero slapped the heroine in the face.

In the stunned silence which followed, a little voice piped up!

"Mommy," it said, "why doesn't she slap him back like you do?"

Advertising

The restaurant had quite a line of applicants the day it put this sign in the window: "WANTED: man to wash dishes and two waitresses."

Confirmed Diagnosis

Professor (addressing medical students): "The muscle of the patient's leg has contracted until it is much shorter than the other. Therefore, he limps. Now what would you do in such circumstances?"

Student: "I'd limp, too."

Mirage

A fellow was bragging about his new girl friend. "She's a vision of beauty," he said, "a regular mirage."

Friend: "I get what you mean but you're using the wrong word. A mirage is something you see but can't feel."

Fellow: "That's her."

More Dancers Than Readers

To the blonde dancer who had just finished her act in the floor show the rich young man said, sadly: "Tell me, why do you, a beautiful, talented, and apparently educated girl, dance in a sordid joint like this?"

Blonde: "I don't know, unless I meet a great many more prominent young men here than I did when I was a public librarian."

Some Heat!

A Nebraskan, an Ohioan and a Texan died and all were being cremated on the same day.

The Nebraska man was cremated first and when his ashes were removed, they filled a quart jar. The Ohio man was next and his ashes required a pint container. The Texan was last. After 15 hours, the furnace door was opened. Out walked the Texan, mopping his face with his handkerchief.

"Boy," he said, "if we get two more days of this hot weather, it'll ruin the cotton for sure."

Mind Your Business

Train Robber: "Out with your dough. I'll kill all men without money and kiss all women."

Elderly Gent: "You shall not touch these ladies!"

Old Maid in upper berth: "You leave him alone. He's robbing this train."

Football Season

There are a lot of things we like about the football season. Aside from everything else, it's the only time of the year a fellow can walk down the street with a blanket on one arm and a girl on the other without having people ask so many fool questions.

Don't Need It

An old lady took her first airplane ride on a hot summer day. When the plane had been in the air for some time, she pointed to the propeller and said, "All right, young man, you can turn off the fan now; I feel much cooler."

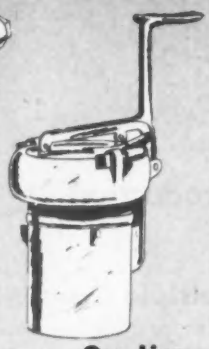
Statistics

There are 90,000 hairs on the average redhead's scalp and over 150,000 on blondes. So let this serve as a warning: The chances of getting a blonde hair on your coat are almost twice as many as a redhead's.

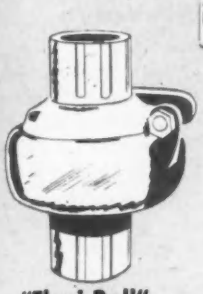
Femininity

There's something feminine about a tree. It does a strip tease in the Fall, goes with bare limbs all Winter, get's a new outfit every Spring and lives off the saps all Summer.

Malleable Couplings



Gas Line Blowdowns



"Flexi-Ball" Joints

"Big Inch" Couplings

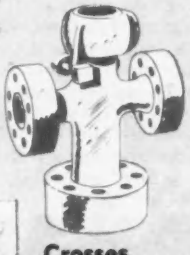
Forged Steel Couplings

Scraper Trap Couplings

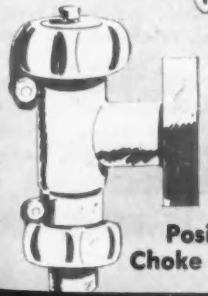
Adjustable Wing Valves

Tees

Christmas Tree Flow Manifolds



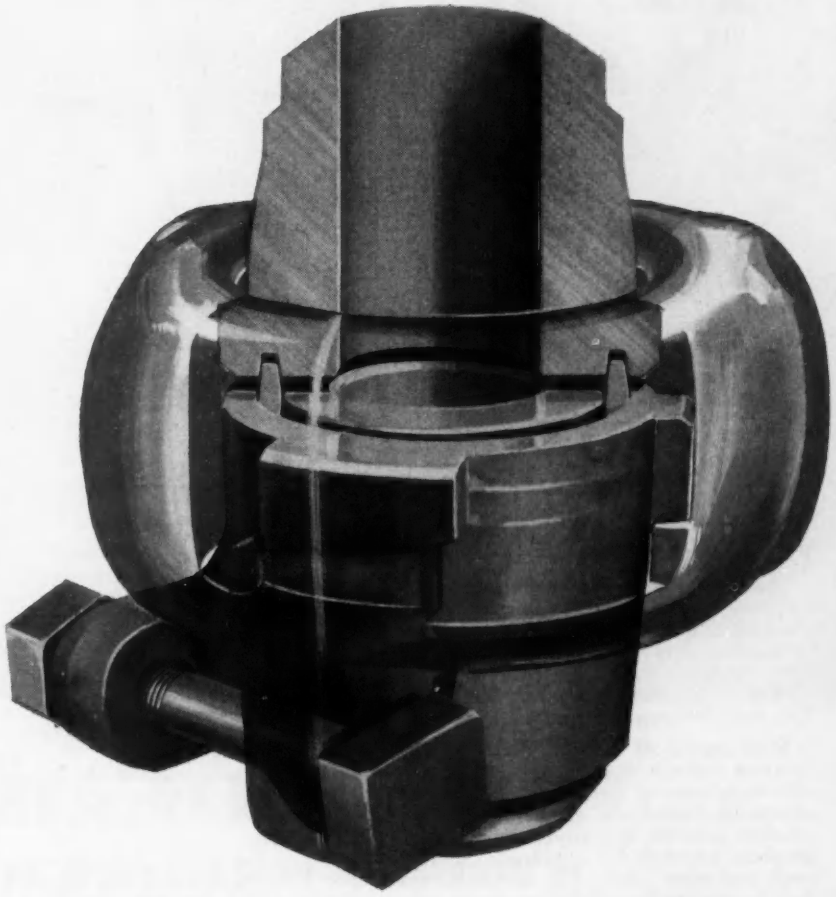
Crosses



Positive Choke Bodies

UNIBOLT

—lightest—strongest and busiest coupling in the oil world



Lightest because its design rules out bulk, such as flanges, multiple bolts and nuts, hammering lugs, etc. It effectively uses every ounce of steel. The result: minimum weight, maximum compactness for lower cost handling and ease of installation.

Strongest because, size for size, the UNIBOLT design places more metal in shear.

Busiest because it has replaced flanges and threaded connections on all sorts of Christmas tree fittings, rotary hose connections, and pipeline equipment.

The cutaway view presented here graphically illustrates how the mating tapered shelves on the lug hub and nut member are drawn together in a wedging action by a single bolt (two bolts on large sizes). Thus, by means of leverage, tremendous pressure is applied to seats and seal ring, the latter being available in steel, gasket material, or self-sealing rubber, depending on service conditions. The bolt is under initial stress only. Hubs may be threaded or provisioned for welding.

THORNHILL CRAVER CO.
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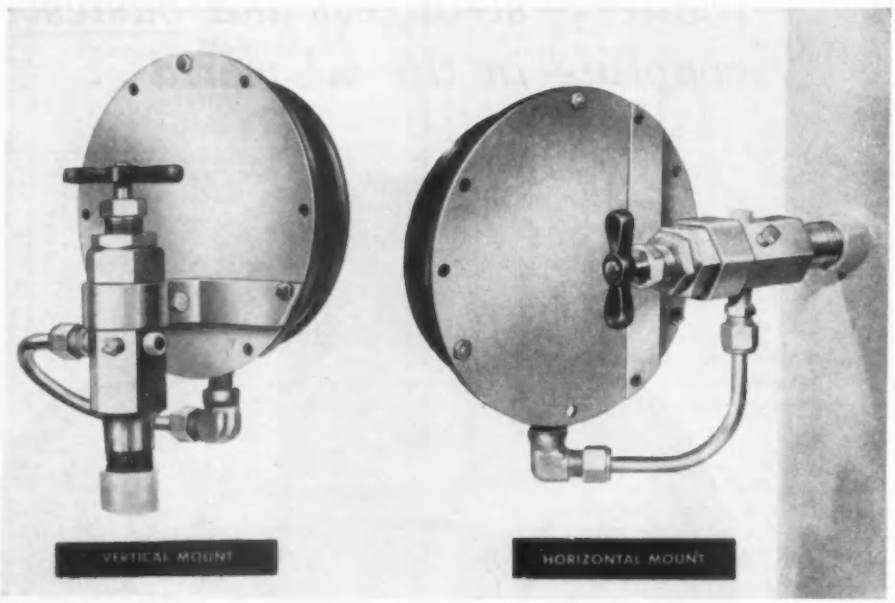
What's New In Equipment

Drilling • Production • Exploration



Multiple Opening Valve

The new Gauge Type Hex Valve is a low cost, high quality, high temperature, and durable valve with multiple openings for directly connecting to tanks, pipe or wherever it is desirable to provide for a gauge, bleeder, vent, instrument, connection or taking of samples.

It provides two outlets in the body so that a gauge may be connected to one side and an instrument, sample connection, or bleeder, to the other. It also provides a safety bleeder within the body so pressure can be released safely before disconnecting lines or gauges. Its use eliminates additional valves and pipe fittings, with the advantage of supporting the gauge on a bracket.

Valves are provided with ½- or ¾-inch end connection; ¼- or ½-inch side connections.

For more data, circle **No. E1** on Reader's Service Card, last page this issue.

Voltage Welder Line

Harnischfeger Corporation's Welding division at Milwaukee, Wis., has announced a new line of modified constant voltage welders that permit better and fuller control over a wide range of applications. The line consists of 300, 500, 750, and 1200-amp machines.

Main feature of the new P&H modified constant voltage machines is an adjustable slope control that gives a softer arc, eliminates burn-back and stubbing, and provides a stable, spray-type deposit when properly adjusted for aluminum, stainless steel, and other alloys. The adjustable feature of this control is also extremely valuable in smoothing out both semi-automatic Unionmelt and open-arc steel welding. It also eliminates the possibility of erratic welds due to high current surges while working on difficult welding jobs.

The chief advantages of constant-voltage welding are simplified operation, lower installation and power costs, and X-ray welds for inert gas, submerged arc, semi-automatic and all metallic-arc automatic welding processes. This new development now extends these advantages to a greater variety of applications and to jobs where it is necessary to change electrode sizes.

For more data, circle **No. E2** on Reader's Service Card, last page this issue.

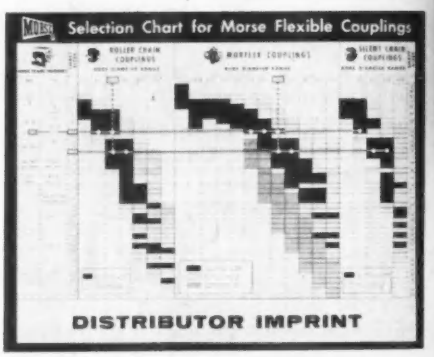
Thread Repair Kits

The George J. Fix Company of Dallas, southwestern representatives for the Heli-Coil Corporation announced a complete line of thread repair shop packs.

The thread insert makes possible permanent repair of damaged or stripped threads in the field with an 18-8 stainless steel insert, which brings a damaged thread back to original size with greater strength than the original tapped hole. Heli-Coil inserts have military standardization, and have been widely used throughout all types of industry. The new thread repair kits are particularly useful for the petroleum and pipe line industries.

Heli-Coil inserts are available from 4-40 to 1½-inch sizes in both coarse and fine threads. They are also made in 14 mm, 18 mm, ⅞ inch-18 spark plug sizes and taper pipe thread from ⅛ inch-27 to 1 inch-11½.

For more data, circle **No. E3** on Reader's Service Card, last page this issue.



Coupling Selection Chart

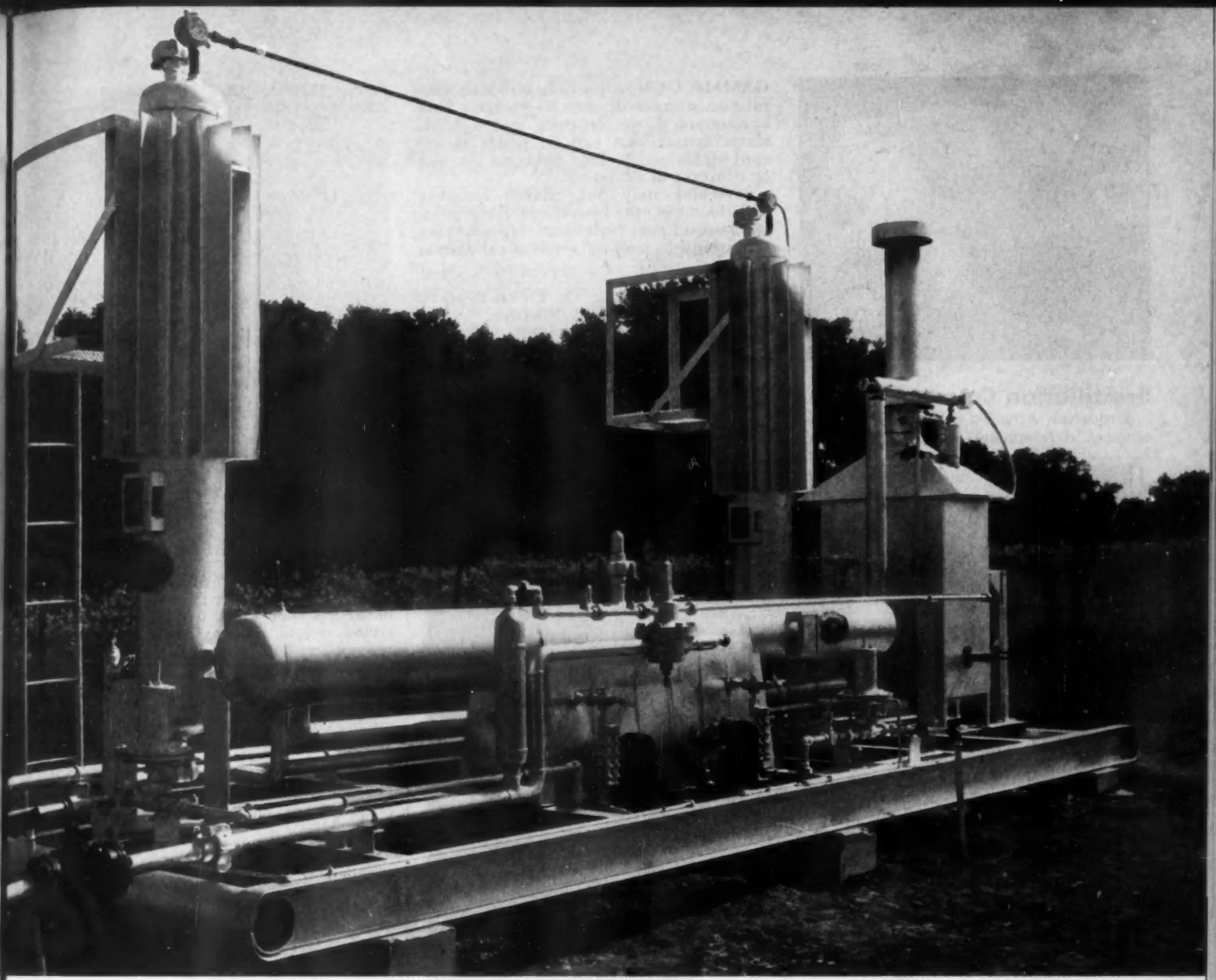
A new 22- by 17-inch coupling selection chart, developed by Morse Chain Company, Ithaca, N. Y., reduces the time necessary to select a flexible coupling to a matter of minutes.

The main horizontal headings of the chart are the three coupling types and sizes with the bore diameter range of all coupling halves. N.E.M.A. electric motor frame numbers, both old and new, are listed in the extreme left hand column in sequence according to shaft size. The next column lists given shaft sizes ranging from ¼-inch to 4½-inch. This shaft size column is repeated as the extreme right-hand column for convenience of the user.

Under each separate coupling heading, the bore diameter range is indicated by means of a color code as a cross reference with the appropriate shaft size. Solid blue, solid yellow and blue cross-hatched rectangles are used.

For more data, circle **No. E4** on Reader's Service Card, last page this issue.

(This item supplements Morse Chain Co. data on Pages 3514-3517 of the Composite Catalog, 21st Edition.)



PARKERSBURG DAU WELDRIER

delivers greater dehydration efficiency -- requires ⅓ less desiccant -- uses 80% less fuel gas

Since the DAU was designed to take full advantage of the dynamics of the adsorption process, each particle of desiccant develops the maximum possible efficiency. This enables the DAU to dehydrate a high pressure gas stream with only a few hundred pounds of desiccant compared to several thousand pounds required by conventional dehydrators.

Moreover, regeneration of the desiccant packs requires only about 20% of the fuel gas normally required by ordinary dehydrators. The savings on desiccant and fuel gas alone amount to hundreds of dollars—more than enough to pay out the low first cost of the PARKERSBURG DAU WELDRIER in an unusually short time.

It will be worth your while to talk over the many advantages of the new DAU WELDRIER with your Parkersburg Representative.

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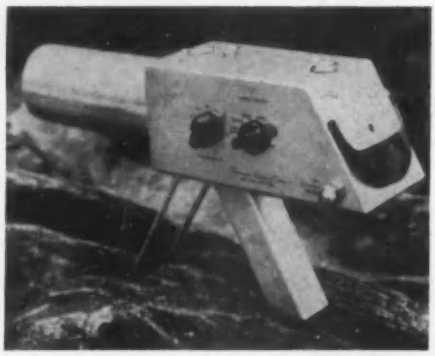


Scintillation Counter

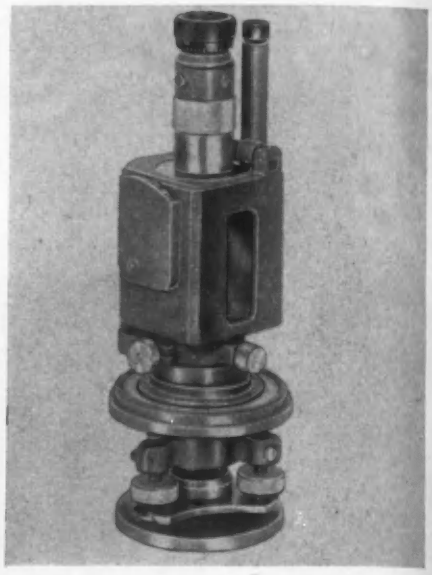
Universal Atomics Corporation announces development of the Model 511 GAMMA GUN, a portable airborne scintillation counter. It directly operates both a standard 1 ma recorder and a UAC alarm system that can be preset to record visibly and audibly either an increase or decrease in radiation.

Weighing only 6½ pounds complete with batteries, the instrument features an eleven-transistor high gain circuit, long operating life, and an internal calibration unit.

For more data, circle **No. E5** on Reader's Service Card, last page this issue.

Pocket Theodolite

Wild Heerbrugg Instruments, Inc. is offering a lightweight, miniature theodolite designed for preliminary and smaller survey work of all types. The instrument has an over-all dimension of less than three inches by eight inches including the metal cylinder container, and its seven-pound weight includes container and extension leg tripod.



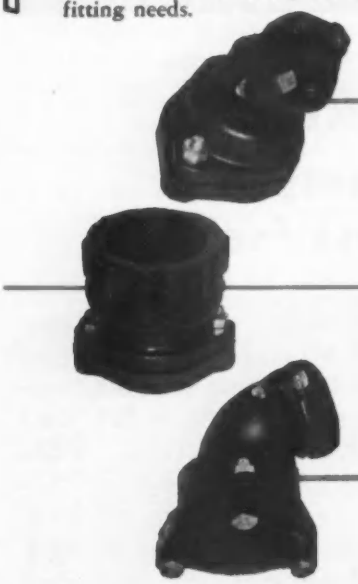
Optically, the theodolite presents an upright image with 5X magnification and an eight-degree field of view. Horizontal circle reading is to one inch and the vertical to two inches. A prism under the telescope gives a vertical range of 72 degrees.

For more data, circle **No. E6** on Reader's Service Card, last page this issue.

YOU JUST CAN'T BEAT SLIP-ON'S*!

You can accomplish maximum economy by using Enardo **SLIP-ON** fittings for all low pressure fitting installations. Some users have reported a 50% savings in time and money because of their labor saving qualities. No unions are needed with Enardo **SLIP-ON** fittings, which means easier, faster, and cheaper lease installations.

Consult your Enardo salesman or call the Tulsa office for your own particular fitting needs.



4" to 3" and 4" to 2" **SLIP-ON** 45° reducer ells. Principally designed for use in equalizer line installations.

4" N.P.T. to 3" **SLIP-ON** reducer connections. For connections between screwed end pipe and blank end pipe. Also used for water-leg installations.

6" to 4" **SLIP-ON** 90° reducer ell. General purpose fitting for installations where working pressures do not exceed 150 p.s.i.

*Reg. T. M.

ENARDO manufacturing company

BOX 1647 • TULSA, OKLAHOMA

Quick Starter Kit

Start Pilot, a proven permanently installed device which provides quick starting for gasoline and diesel engines, is the first precision engineered starting device available in America. It is distributed throughout the U. S. by the Wilco Company and Start Pilot Corp.

Start Pilot injects a small quantity of ignition-promoting fluid as a fine spray, mixed with air, into the engine intake manifold. This supplies quick starts, even at temperatures as low as —60° F., saves engine wear and lengthens battery life, and keeps the engine firing until the regular fuel source can sustain combustion. Start Pilot has been scientifically tested for use on trucks, tractors, busses, hoists, bulldozers, marine engines, snow plows, plus all other gasoline and diesel powered equipment.

The Start Pilot unit uses a special low ether content blend of Sure Fire Motor

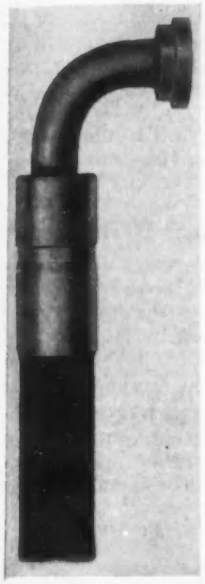
Starting Fluid packed in hermetically sealed capsules which can be stored indefinitely without deterioration.

The Start Pilot kit consists of the main unit containing the capsule chamber and the hand-operated double action air pump; a spray nozzle which is screwed into the engine intake manifold, and copper tubing which connects the pump unit to the spray nozzle.

For more data, circle **No. E7** on Reader's Service Card, last page this issue.

Split-Flange Coupling

The patented Anchor Flanco 4-Bolt Split-Flange Pressed-on Coupling is now available with the added feature of a newly developed, patented, 360 degree swivel joint for maximum convenience in positioning and installing.

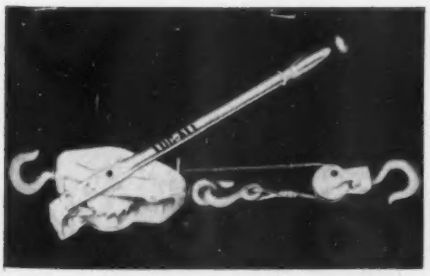


This new patented swivel, combined with the no-thread, no-leak features of the Anchor Flanco Coupling "O" Ring Seal design gives the engineer new design freedom and prevents danger of hose twisting. The elimination of pipe threading operations, use of separate union and swivel connectors, gaskets and sealing compound will show a savings in both material and production costs.

The new Anchor Swivel Flanco is available in all sizes from ½-inch through 1½-inch, and in all standard bends from 0 degrees to 90 degrees. Thinner sections on valve and pump bosses are made possible with added savings in size, weight and money.

A Flanco Hose Assembly may be connected and disconnected time after time without danger of leaks. Only small automotive type wrenches are needed to make up a joint.

For more data, circle **No. E8** on Reader's Service Card, last page this issue.



Long Reach Winch Hoist

A lightweight 1½-ton capacity ratchet leaver hoist unit is being offered with a standard lift of 30 feet, which makes it ideally suited for long pulls and lifts, thus eliminating the need for any staging.

This new Lug-all model 3000-30 weighs 13¾ pounds and includes a highly flexible aircraft cable that permits lifting, pulling or lowering a 1½-ton load a distance of 15 feet (when used as shown) or a ¾-ton load a distance of 30 feet (using cable in a single line).

It includes these features: a rugged, protective type main frame of high grade aluminum alloys that allows instant inspection and easy cleaning, oil-for-life bearings, stainless steel springs, three workable hooks, smooth operation in any position and a built-in pulley that can be used as a snatch block in close quarter work.

A safety handle bends before the unit can be overloaded to prevent costly accidents. An interlocking pawl system securely locks the load. There are no brakes to slip. Free release only operates under no load conditions.

A tamperproof set-up can be obtained by removing the reversible handle. All units are factory tested to 11 percent overload and are guaranteed for one year against defective parts and/or workmanship. Another new unit with the same basic design, the Lug-all model 2250-38, weighing only 13½ pounds, offers a 19 foot lift or pull with a capacity of 2250 pounds and a 38 foot reach with a capacity of 1125 pounds.

For more data, circle **No. E9** on Reader's Service Card, last page this issue.

For Longer Service . . . Greater Joint Strength . . .
More Footage at Lower Cost

use

SPANG
Drilling Stems

with Forge Hammer-Welded, Fully Heat-Treated, Precision Machined Box and Pin Joints . . .

SPANG DRILLING STEMS are made of machine straightened special bar quality open hearth steel, of the right analysis to assure the greatest vibration dampening effect. Box and Pin joints are hammer-welded, fully heat-treated, and have precision machined threads to provide the strongest, most wear-resistant joints obtainable. As a result SPANG DRILLING STEMS, with high strength joints, give longer than average service and drill more footage at lower cost.

REPLACEMENT BOXES AND PINS

. . . of the same carbon steel analysis as those integral with original stems are available in all sizes, lengths and joint combinations for forge or electric welding to stems when renewal is required.

For complete information on Stems and Replacement Boxes and Pins, and for FREE CATALOG of other SPANG CABLE TOOLS, consult your nearest SPANG DEALER or write direct to:

SPANG & COMPANY

DEPT. O-6 • BUTLER, PENNSYLVANIA

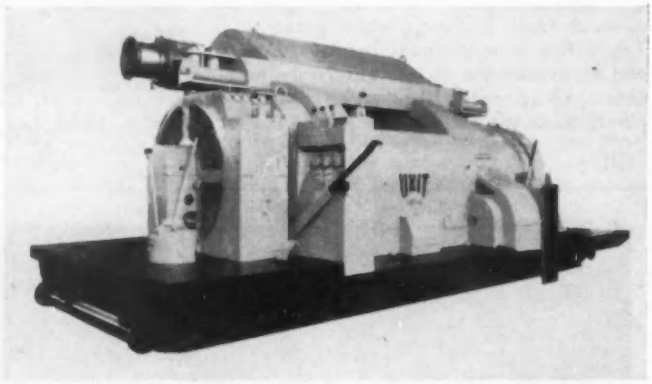
For over 60 years Manufacturers of Spang Weldless Jars and a Complete Line of Cable System Drilling and Fishing Tools for Oil and Gas Wells, Water Wells, Prospect Drilling and Shot Blast Holes.

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

DRILLING

Offshore Model

Unit Rig Model U-914-A drawworks is built for 900 to 1400 input horsepower for medium depth drilling. This unit is adaptable for offshore operations. The U-914-A features an extra large drum, water circulation brake rims and identical high and low drum clutches (38-inch VC-1200 Ventorque with a positive lock-in on the low clutch).



For portability, the hoisting drum, transmission, and auxiliary brake are mounted on a single skid 9 feet by 22 feet 6 inches. The approximate weight of the unit, less sand reel, catheads and auxiliary brake, is 45,575 pounds.

The three forward drives and sliding gear reverse in the transmission, combine with two drum drives to give six forward and two reverse speeds to the drum. One reverse and three forward speeds are available to the rotary countershaft, catshaft and optional sand line drum.

The transmission is lubricated by two chain driven oil pumps. The discharges are manifolded and either pump can furnish adequate lubrication.

Major design criteria for this new rig have been simplicity of constuction, ease of operation, and rugged dependability for long, trouble free service. All hoisting drives and transmission chains are 1¾-inch pitch quad. The rotary countershaft and catshaft chains are 1¾-inch pitch double. All transmission shaft support bearings are identical and sprockets teeth are induction hardened.

Maximum wire-line life is assured by the balanced-drum design. The extra large drum (27-inch diameter barrel by 53¼ inches long) allows three wrap spooling when hoisting 90-foot stands with a 10 line reeving system using 1¼-inch wire line.

The total braking area on the hoisting drum is 2900 square inches with 320 degree bank wrap. High braking efficiency, drag-free release, and easy application is provided with the compounded self-equalizing type "B" brakes.

Special attention has been given to corrosion problems, particularly for offshore operations. Critical hardware and linkage are cadmium plated plus iridite finish to provide extra protection.

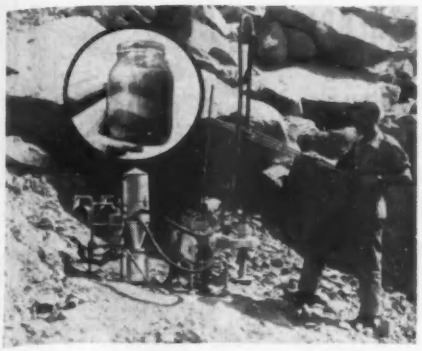
Servicing is simplified by a centralized greasing unit for lubricating the brake linkage. The unit can be lubricated while the rig is in operation. Transmission shafts can be removed independently. The clutches may be serviced without shaft disassembly. Low and high drum clutches and sprockets are mounted on the outside of the shaft support bearings.

(This item supplements Unit Rig & Equipment Co. data on Pages 4957-4988 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E10** on Reader's Service Card, last page this issue.

Portable Vacuum Drill

A compact, portable rotary drilling system weighing only 125 pounds which removes all cuttings from the hole by vacuum has been developed by Houston Tool Company, Santa Susana, Calif. Known as the Mighty Midget, the gasoline powered rig is easily carried by two men, facilitating use in rough terrain, impossible to reach by truck or car. The unit is quick to set up and the rotary table can be



swiveled to drill at any angle, vertical or horizontal.

High velocity air cools the bit and lifts the cuttings internally through the drill stem. Cuttings are separated from the exhaust and are deposited in a transparent glass container in the order removed, furnishing visible core samples easily correlated to depth.

The vacuum system requires no water, frequently impossible to supply or transport. It also insures against loss of circulation in fissures or broken formations and eliminates any possibility of contaminating cores.

The Mighty Midget drills a 1¾-inch hole up to 100 feet deep in dry formation and utilizes a nine horsepower McCulloch engine. Among its many applications are shot and blast hole operations, exploratory mining, location of water strata, evaluation of underground deposits, geophysical work, earth sampling, and drilling of holes to water for establishment of satisfactory ground connections for telephone and electrical circuits, etc. Larger units employing a similar vacuum system are also manufactured.

For more data, circle **No. E11** on Reader's Service Card, last page this issue.

Electric Tachometers

The Martin-Decker Corporation recently introduced a line of electric, self-energizing tachometers for the measurement of rotary-table speed, pump-stroke count, and engine rpm. The advantages of these instruments are their ability to be installed at considerable distances from their take-off points, the ease at which several meters can be actuated by one generator, the lack of rotating cable which requires periodic replacement, and the ability of the meters to be calibrated to any gear ratio on the rig.

The take-off is connected to the engine, pump, or rotary drive (depending upon the type of instrument) which turns a small generator. A low-voltage signal is transmitted through an electric cord to a meter or meters installed anywhere on or near the rig.

(This item supplements Martin-Decker Corporation data on Pages 3141-3168 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E12** on Reader's Service Card, last page this issue.

Tiger Tail Display

This counter display, with the yellow and black nylon end of a spinning chain

serving as the tiger's tail, will soon be in hundreds of supply stores to introduce the new Web Wilson "Tiger Tail" Spinning Chain.

Made to exacting specifications, this proof-tested spinning chain is available in popular link sizes and chain lengths, and is offered as an outstanding addition to the line of Web Wilson drilling tools.

(This item supplements Web Wilson Oil Tools data on Pages 5221-5252 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E13** on Reader's Service Card, last page this issue.

OTIS SAFETY VALVES

Otis—"First in Pressure Control"

PLUGS for PRESSURE

FORGED STEEL HIGH PRESSURE PLUGS WITH

Dry Seal

TAPERED THREADS

Both CAPITOL square head and hex head solid plugs have dry seal tapered threads to assure safe, permanent high pressure installations. Individual thread protectors for maximum protection. Conveniently packaged for easier handling.

Square Head Solid Plugs sizes 1" thru 2", all forged steel. Hex Head Plugs sizes ½" thru 2" machined from solid bar.

You'll like these thread protectors, too!

CAP CAPITOL

MFG. & SUPPLY CO.

COLUMBUS, OHIO

COUPLINGS — NIPPLES — UNIONS — RADIANT HEAT FITTINGS — FURNACE COILS — WELL SUPPLIES — STEEL PIPE FITTINGS

PRODUCTION

BJ Spider-Elevators

Byron Jackson Tools announced the first combination casing spider-elevator. Designed for operation as either a spider or elevator it has a safety-rated capacity of 500 tons, a rating which is claimed to be the world's largest for either a spider or elevator.

This new BJ spider-elevator is of the slip type and eliminates the need for two separate pieces of equipment. It features unitized slips which may be manually or power operated.

(This item supplements BJ Oil Tools, Byron Jackson, Division of Borg-Warner Corporation, data on Pages 907-1004 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E14** on Reader's Service Card, last page this issue.

Gas Dehydration Unit

A gas dehydration unit featuring the use of calcium chloride pellets in a tower of patented design has been put into production by the Manufacturing division of the Fish Engineering Corporation at Aztec, N. M.

The dehydrator has proved to be much more efficient and less expensive than former methods. Reduction of the water content in well head gas to within limits prescribed for safe pipe line transmission, has in the past been a relatively inefficient and costly process.

Tests have proven the dehydrator removes from 3.5 to 5 pounds of water per pound of $CaCl_2$—which is from two to three times the normal removal.

There is no maintenance required aside from reloading the desiccant and changing of charts. Field tests have shown the unit will depress the dew point from 75 to 100 degrees. Freeze-ups are prevented in temperatures ranging down to minus 60° F.

All vessels in the dehydrator are designed with code corrosion allowance. The equipment operates at well head pressure, this ordinarily eliminating the presence of free oxygen which promotes corrosion. A horizontal separator with controls and instrumentation are packaged with the dehydrator.

Fish Engineering's division of Manufacturing shops are now producing four models of the dehydrator. They range from a capacity of 2500 MCF a day with working pressure of 990 and hydrostatic pressure of 1500 to 5000 MCF a day with designed working pressure of 660 and hydrostatic test pressure of 1000.

For more data, circle **No. E15** on Reader's Service Card, last page this issue.

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New Equipment Catalogs and Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader's Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Petroleum Gage Catalog

W. H. Curtin & Company, specializing in laboratory apparatus, furniture and chemicals, has recently released their new catalog on petroleum gaging equipment. It lists all types of centrifuges—replacement parts and accessories, sample bottles, corks, Hydrometers, clamps, mailing cases, gager's tape, plumb bobs, oil thieves and parts, tank thermometers—all the equipment essential for gaging petroleum and its by-products used by drilling, production, pipeline and refinery personnel. The catalog is profusely illustrated, with complete descriptions and prices.

To get a copy, circle **No. E16** on Reader's Service Card, last page this issue.

Steel Tank Brochure

Informative and interesting features are included in a new 16-page brochure just published by the Columbian Steel Tank Co. of Kansas City, Mo. Entitled "Columbian Bolted Steel Tanks" and listed as Catalog No. 656, the brochure features a pictorial description of the use and application of new synthetic gasket materials in the erection of bolted steel tanks as well as a useful table of API dimensional specifications for the more important sizes of bolted steel tanks from 100 bbl. to 10,000 bbl. capacity.

The brochure also shows the application of Columbian tanks by other industries for grain storage, water supply, ore refining, storage of dehydrated alfalfa under inert gas pressure and the adaptation of the bolted steel tank principles to the construction of swimming pools. Tank accessories, such as walkways, stairways, hatches and ladders are also shown and described.

To get a copy, circle **No. E17** on Reader's Service Card, last page this issue.

Vertical Turbine Pumps

A comprehensive book, "The Answers to Your Questions About Layne Vertical Turbine Pumps," has just been published by Layne & Bowler, Inc., of Memphis, Tenn., manufacturers of Layne vertical turbine pumps. Written by a foremost authority on vertical turbine pumps, this 72-page handbound book covers the use of pumps for municipalities, industry and irrigation.

Section one of the book is devoted to a study of the methods of selecting deep well centrifugal pumps to attain optimum efficiency. Charts for determining size and type of vertical pumps operating from 585 revolutions per minute to 1750 rpm are included.

In a section entitled "A Corrosion Problem—3000 Feet Deep," the author describes the actual construction of a well which supplies water to the City of Dallas, Texas, a well which reaches down 2886 feet and delivers over 2,225,000 gallons of water per day.

The entire text is supplemented with graphic tables, photographs, drawings, and charts, to present a thorough and all-inclusive reference book on vertical turbine pumps.

To get a copy, circle **No. E18** on Reader's Service Card, last page this issue.

Cathodic Protection

A 32-page booklet on cathodic protection equipment for corrosion control is available from Standard Telephones and Cables Ltd. Illustrated with numerous photographs and drawings, the data include extensive technical information on installation, inspection and maintenance of the described equipment together with various schematic circuit diagrams. Also included is a listing of other technical bulletins available on request.

To get a copy, circle **No. E19** on Reader's Service Card, last page this issue.

Acid Petrofrac

A new four-page booklet describing Acid Petrofrac is being issued by Dowell Incorporated. It explains the production boosting service developed by Dowell.

To get a copy, circle **No. E20** on Reader's Service Card, last page this issue.

Perforating Gun Booklet

Perforating Guns Atlas Corporation announces the completion of their entirely new Catalog #5758, which is now available.

Topics covered by the new and enlarged edition of PGAC's catalog, all fully illustrated and explained in detail, include Bullet perforating services, caliper survey and dual odometer for depth control.

To get a copy, circle **No. E21** on Reader's Service Card, last page this issue.

CaCl Dehydration

A new gas dehydration unit for gas wells which used calcium chloride pellets in a tower of patented design is described in a 16-page booklet issued by the Fish Engineering Corporation, Manufacturing division, Aztec, N. M.

To get a copy, circle **No. E22** on Reader's Service Card, last page this issue.

Selenium Information Sheet

Corrosion Services Incorporated has printed a paper describing the new air-cooled selenium rectifiers, for the cathodic protection against corrosion.

To get a copy, circle **No. E23** on Reader's Service Card, last page this issue.

Technical Recovery Paper

Parkersburg Rig and Reel Company has issued a technical paper covering the advantages of DAU Units for well head dehydration and hydrocarbon recovery. It offers a comparison of the new type dry dessicant adsorption unit with conventional separation, low temperature separation and refrigeration units.

To get a copy, circle **No. E24** on Reader's Service Card, last page this issue.

Butterfly Valve Manual

This 40-page catalog put out by The Henry Pratt Co., of Chicago, is designed to help engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes Henry Pratt rubber seat butterfly valves from four inches diameter up, for handling liquids and gases.

To get a copy, circle **No. E25** on Reader's Service Card, last page this issue.

Well Head Catalog

All National well head equipment is cataloged in Bulletin No. 444 newly issued by National Supply Company, Pittsburgh. The 20-page booklet gives specifications and design features of equipment for the whole range of well depths and pressures. Illustrated instructions for triple-sealing a wellhead are included.

To get a copy, circle **No. E26** on Reader's Service Card, last page this issue.

Ramsey Winch Folder

The complete line of winches for all trucks is shown in the new four page, multicolor bulletin Number 1003, put out by Ramsey Winch Manufacturing Company. In addition to winches, Ramsey shows their line of speed reducers, power take-offs, hanger bearings, universal joints and equipment needed for installation and operation of Ramsey Truck winches.

To get a copy, circle **No. E27** on Reader's Service Card, last page this issue.

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